SEPTEMBER-OCTOBER 1961

ORDNANCE

LAND • SEA • AIR • SPACE

New mobile 155-mm. howitzer T196

In this issue: Mark S. Watson • Maj. Reginald Hargreaves • Maj. Gen. D. E. Beach
W. O. Foss • A. J. Zaehringer • Rear Adm. J. D. Hayes • E. R. Swick • Dr. C. E. Carver

Alcoa Aluminum armor plate under fire at The U.S. Army Aberdeen Proving Ground. Photographed by the Burns Bros.

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VOL. XLVI SEPTEMBER-OCTOBER 1961 NO. 248

The Cover.—The Army's 155-mm. self-propelled howitzer T196 weighs 47,000 pounds, including 19,000 pounds of aluminum, giving it increased range, speed, and mobility over rough terrain (Army photo).

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ARMAMENT TECHNOLOGY

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THE CONTENTS OF THIS ISSUE IN BRIEF

A Single Supply Service? (p. 196) . . . . While centralized procurement and other similar practices have been recommended and adopted for the armed services in many instances, there are still a number of areas where such practices, while they might save some money in the first instance, could, under combat conditions, cause a disastrous loss of time and interfere with the most efficient system of command. Mark S. Watson, recently cited by the Secretary of Defense for his military reporting, describes both sides of the problem.

The Fallacy of Neutralism (p. 200) . . . . In past centuries, neutrality often was a legitimate posture for a nation to assume. But, as Maj. Reginald Hargreaves says, "Since 1945 the whole rationale of the world has changed. Riven by two antagonistic, irreconcilable ideologies, ever hovering on the brink of open warfare, it has passed the stage where neutralism can assert its erstwhile right to stand aside."

Reliability—Not Gadgets (p. 203) . . . . The Russian proverb, "The better is ever the enemy of the good," might well be applied to our modern weapons, according to Maj. Gen. Dwight E. Beach who believes that our armament is becoming too sophisticated and complicated to operate and maintain efficiently and that, instead, we should seek weapons that are simple, effective, reliable, and cheap. The final criterion should be: Will it help the combat soldier move across the battlefield to his objective?

Survival in Nuclear War (p. 207) . . . . Although it is true that a nuclear attack on this country could threaten the existence of almost every citizen, it is likewise true, as Kendall D. Moll points out, that proper blast and fallout shelters, coupled with practical plans for evacuation of congested target areas, could greatly reduce the number of casualties and permit our survival as a nation.

Civil Defense Is Vital (p. 210) . . . . The United States at last is awakened to the need for civil as well as military defense, and the Government has taken steps to see that these needs are implemented. This staff study by the editors of ORDNANCE reviews the highlights of the situation.

Tomorrow's Torpedoes Now (p. 212) . . . . Underwater missiles powered by rocket motors and traveling at speeds up to 300 knots while they seek out and destroy enemy submarines are the goal of the Navy's torpedo research and development program. Meanwhile, the current arsenal of underwater weapons is well stocked with effective armament, according to William O. Foss.

Soviet Rocket Forces (p. 216) . . . . The Reds have been slowly replacing conventional artillery with missiles, and at present they have a complete arsenal of

large and small weapons. According to Alfred J. Zaehringer they reportedly are now able to airlift about five fully mechanized, nuclear-armed rocket divisions to any spot on earth.

Loss of the Norfolk Yard (p. 220) . . . . The capture of the Norfolk Navy Yard by the South in 1861 with its stores of powder and heavy ordnance was the most decisive military event of that year and was America's most costly naval defeat until the debacle of Pearl Harbor in 1941. Rear Adm. John D. Hayes here tells of the confused events leading up to the disaster and the personalities involved.

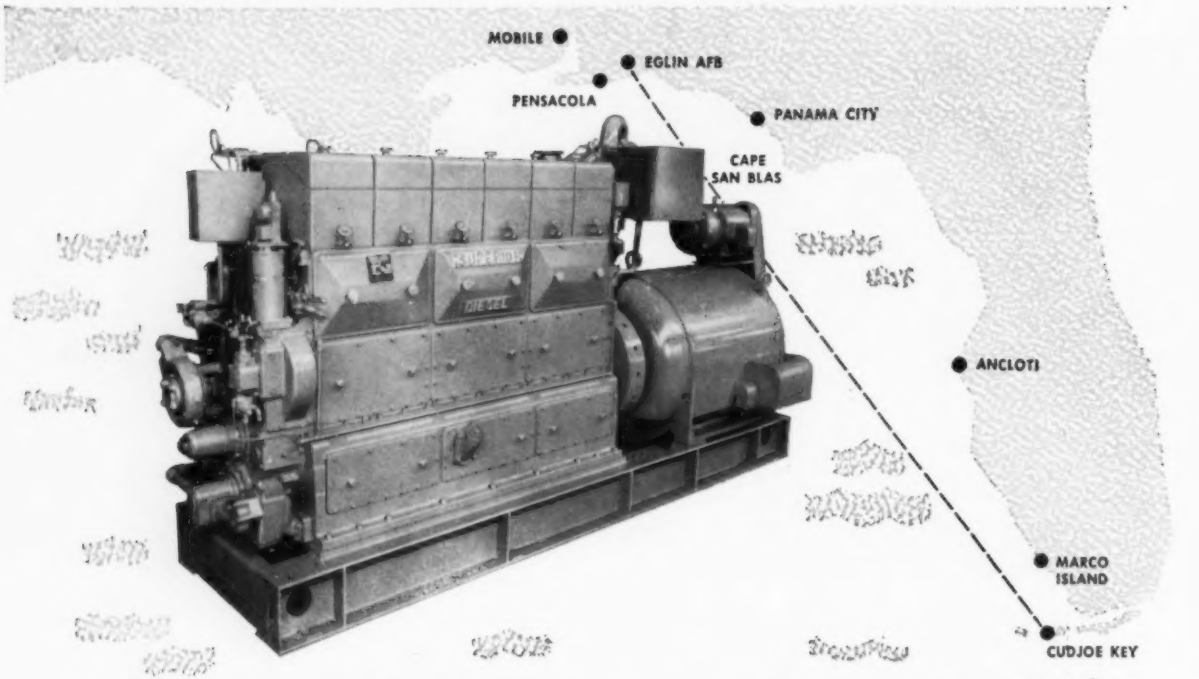
Adhesives for Ordnance (p. 295) . . . . While it is not yet quite possible to glue a broken gun barrel together on the spot and continue firing, the new epoxy resins have made it feasible to make many ordnance repairs in the field. Eileen R. Swick explains the techniques involved and describes the kits which have been developed to apply the new adhesives.

Systematic Errors (p. 299) . . . . Disagreements between laboratories conducting standards of measurement are frequent and inevitable and arise primarily from systematic errors with which the science of statistics is supposedly unable to cope. However, W. J. Youden of the National Bureau of Standards demonstrates that there are workable, if unconventional, methods of detecting such errors.

Guidance for Skybolt (p. 302) . . . . The new astronertial system for the air-launched GAM-87A missile is designed to minimize skill, manpower, and support-equipment requirements and to maximize the self-sufficiency and combat readiness of units of the Strategic Air Command. C. H. Getz here describes the operation and use of this support equipment.

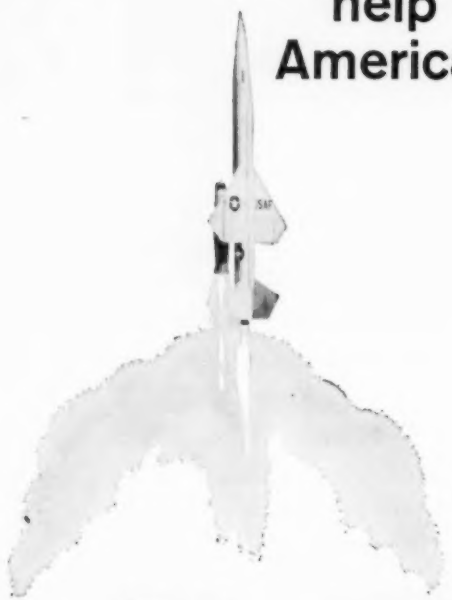
Flight Control Testing (p. 304) . . . . The "moment of truth" in checking the automatic control system for the F-105 Thunderchief airplane comes when the device is actually given an in-flight shakedown to make certain that all the components function together as intended. R. E. Bartholomew describes each step in the testing program.

ABC's of BLC in ASW (p. 306) . . . . An underwater vehicle, such as a torpedo, is slowed down by the effects of "skin friction." There are a number of methods of controlling this fluid boundary layer, as Dr. Charles E. Carver, Jr., describes here, and future research may result in the complete elimination of drag with a consequent great increase in the speed of our undersea missiles.



WHITE SUPERIOR ENGINES

help "keep score" at one of America's newest missile ranges



The Eglin Gulf Test Range (EGTR), consisting of five missile tracking stations, extends 450 miles from Eglin AFB, Florida down the west coast to Cudjoe Key, 23 miles east of Key West. At Eglin AFB and at three of the five tracking stations, power is supplied by White Superior Model 40-SX-6 engine-generator sets. Each of the five Superior engines on EGTR develops 361 BHP to produce 250 KW. At Cudjoe Key (shown below), two of the Superiors provide power for range safety equipment, trajectory measuring systems, drone control and telemetering devices, from which data is sent back to Eglin.

America's newest missile range joins an impressive list of Superior-powered U.S. defense installations, which include the "Texas Towers," portions of "DEW" line and the "SAGE" project, Atlas and other launching stations, and other missile tracking ranges. Government acceptance of White Superior engines for these installations is proof that Superior meets all requirements for rugged dependability, trouble-free maintenance and maximum fuel economy. Superior engines, from 215 to 2150 HP or 150 to 1500 KW, can likewise be custom-engineered to meet your exact requirements, including automatic, unattended or remote controlled operation. Write for complete information today!

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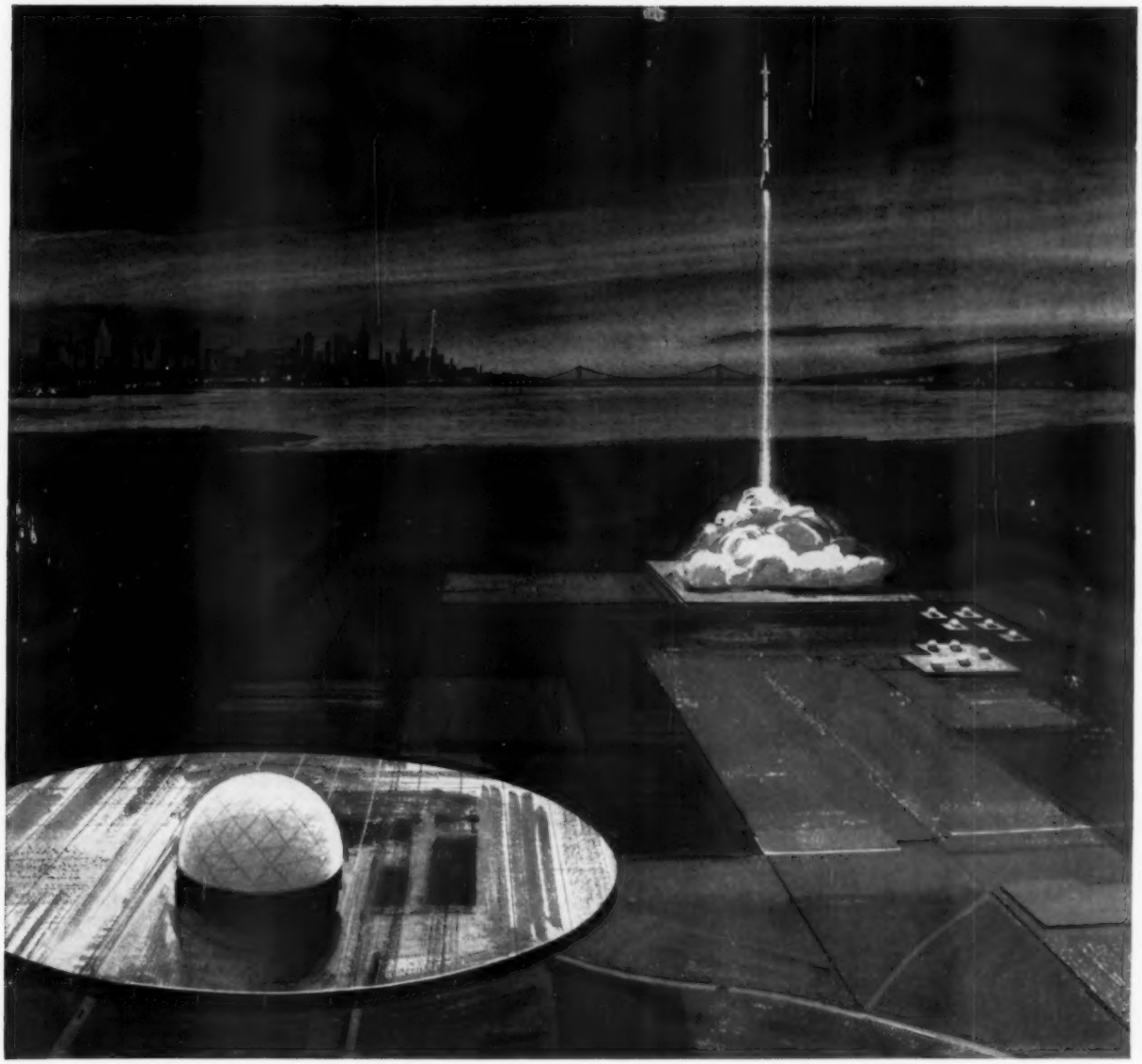

More than 450,000 pounds of thrust lifts the U. S. Army's Nike Zeus missile skyward in a cloud of vapor. The Nike Zeus missile being developed for the project by the Douglas Aircraft Company will be designed to intercept ballistic missiles traveling over 15,000 miles per hour, and destroy them at a safe distance from the defended area.

How do you stop an ICBM?

How do you detect, track, intercept—and destroy within minutes—an ICBM that is moving through outer space ten times faster than a bullet?

Bell Telephone Laboratories may have designed the answer: Nike Zeus, a fully automated system designed to intercept and destroy all types of ballistic missiles—not only ICBM's but also IRBM's launched from land, sea or air. The system is now under development for the Army Ordnance Missile Command.

Radically new radar techniques are being developed for Nike Zeus. There will be an acquisition radar designed to detect the invading missile at great distances. And a discrimination radar designed to distinguish actual warheads from harmless decoys that may be included to confuse our defenses.

The system tracks the ICBM or IRBM, then launches and tracks the Nike Zeus missile and automatically steers it all the way to intercept the target. The entire engagement, from detection to destruction, would take place within minutes and would span hundreds of miles.

Under a prime Army Ordnance contract with the Western Electric Company, Bell Laboratories is charged with the development of the entire Nike Zeus system, with assistance from many subcontractors. It is another example of the cooperation between Bell Laboratories and Western Electric for the defense of America.

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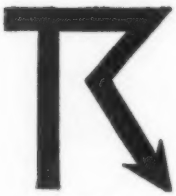

THUNDER

LIGHTNING

ICE PELLETS, SLEET

HIGH DRIFTING SNOW

weather bird

Rain (••) hail (A) thunder (ϗ) lightning (<) ice pellets, sleet (✱) high drifting snow (+) are merely symbols on a weather map—not expected to be problems to the U. S. Army's SERGEANT missile system.

SERGEANT missile system's objectives are to be ready for action in the meanest weather, the most extreme temperatures and environments, at high and low altitudes. It can be checked out by one man with minimum training, emplaced and fired in a very short time by a six-man crew.

The land, sea and air-transportable SERGEANT system, produced for the Army by Sperry Utah—when it becomes operational—will take its place among the tough and dependable sergeants of U. S. Army tradition.

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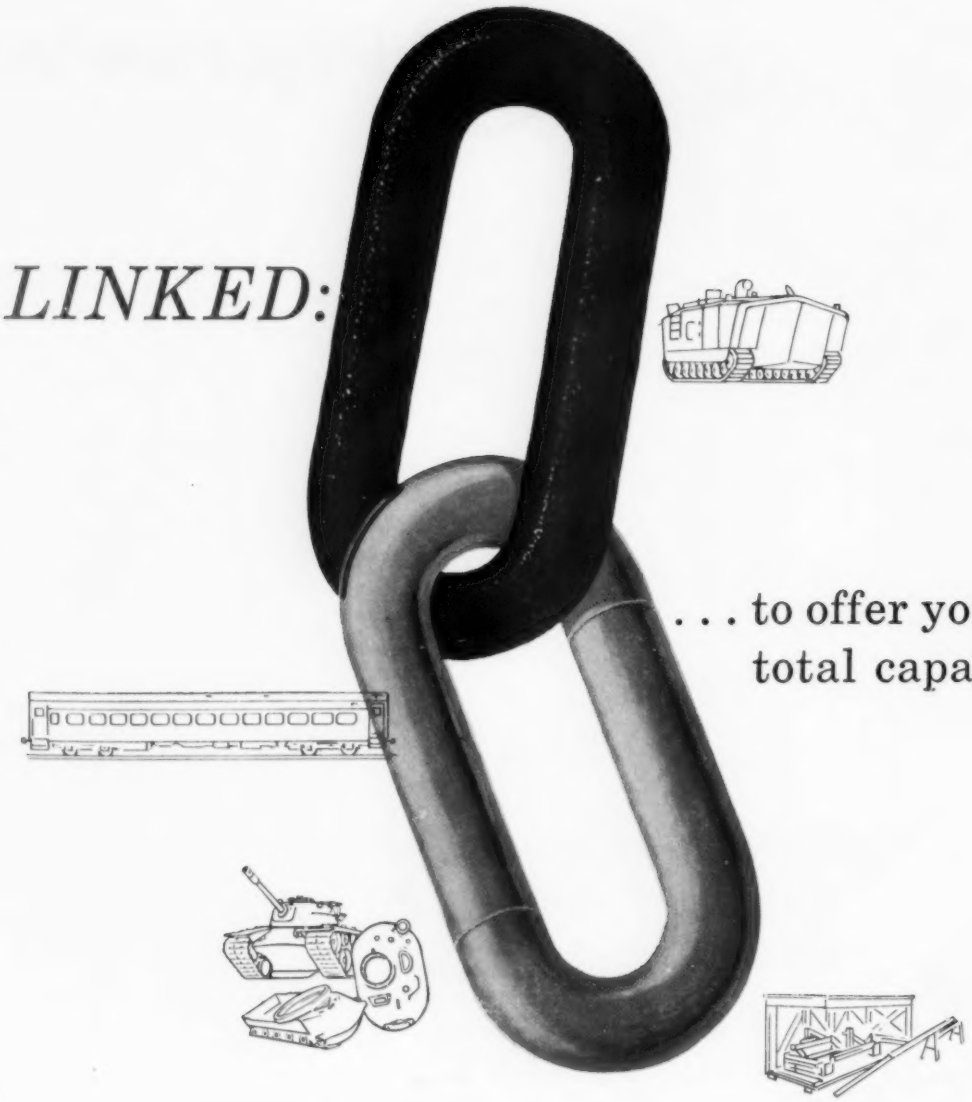

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Guide to a space ride

Inland DC torque motors are integral components of many major U.S. missile guidance and ground support control systems. These direct-drive torquers provide efficient, low speed operation and produce exceptionally high torque to power ratios. Their gearless, pancake design eliminates backlash and other problems inherent in conventional motor design.

Inland products are used in various space instrumentation systems. For example:

- DC torque motors and rotary amplifiers are utilized in tracking antennas for Project Mercury.
- For a space exploration mission, Inland torque motors will help keep solar energy cells constantly aimed at the sun.
- For a new satellite, Inland torque motors and tachometer generators will keep cameras in constant focus on the earth.

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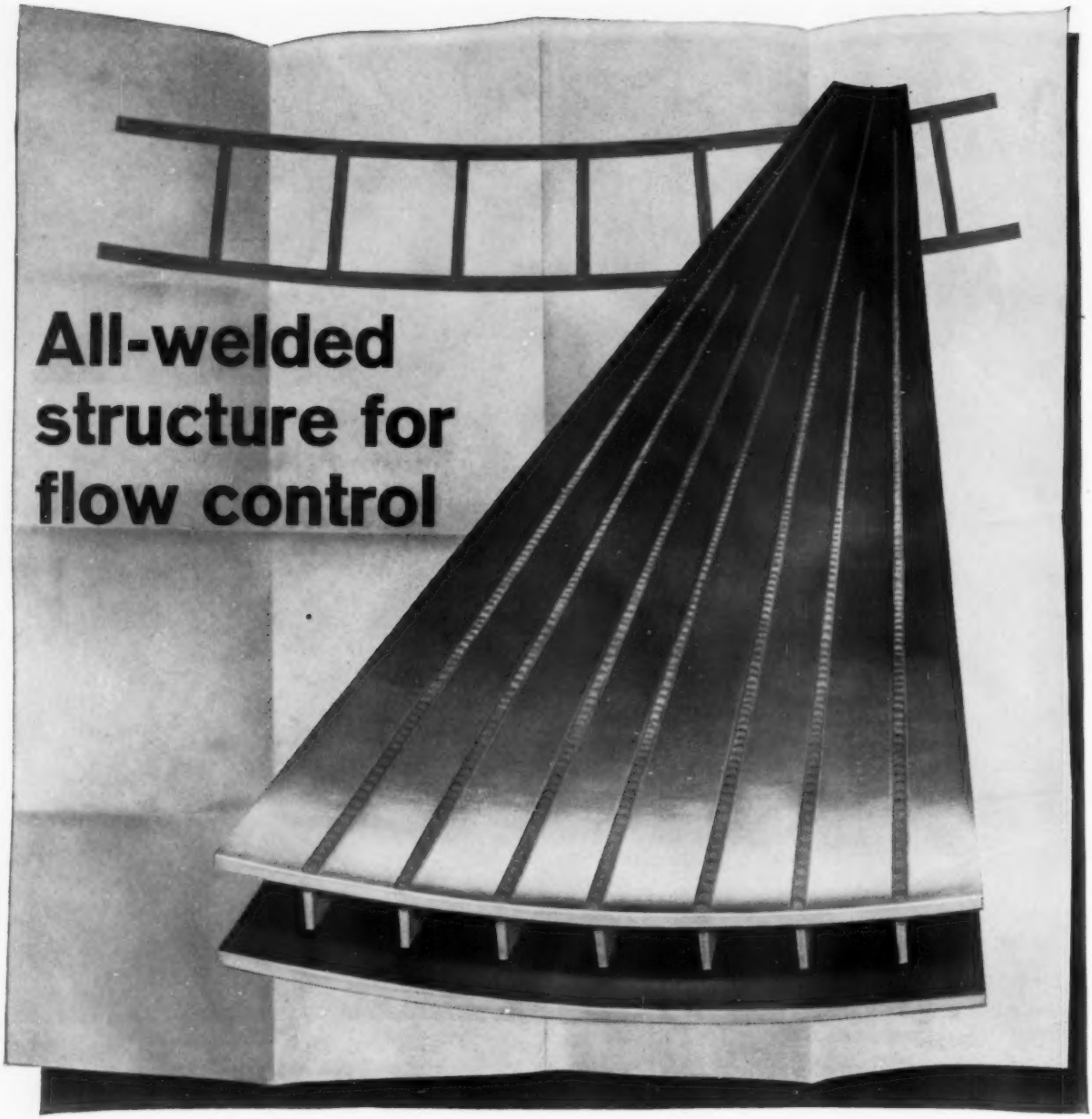

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ATOMIC ENERGY

High-Flux Research Reactor

Design work is now nearly complete for a high-flux research reactor to be constructed on the National Bureau of Standards' new site at Gaithersburg, Md. The reactor, to be known as the NBSR, and its associated laboratories will provide a variety of neutron and gamma-ray sources for use by the Bureau and other Government agencies in the Washington area having the same general requirements.

The new reactor will enable the Bureau to fulfill its growing responsibilities in the many rapidly expanding fields of atomic energy. For example, the Bureau has developed a low-intensity neutron standard that makes it possible for all laboratories to measure neutron radiation intensities in terms of a common reference value; however, it has lacked facilities for measuring high-intensity fluxes such as occur in a nuclear reactor.

Perhaps the most significant function of the NBSR will be its use in studying certain fundamental properties of matter. The intense thermal beams provided by the reactor will constitute a powerful tool in the analysis of atomic and molecular structure by neutron diffraction.

The reactor will advance the measurement, analysis, and understanding of the effects of radiation on substances of all kinds. Such information is of great value in solid-state and chemical physics, and in such practical engineering problems as radiation processing and the effects of radiation on structural materials.

Besides providing radioisotopes for standards of radioactivity, the reactor will supply radioactive tracers for the investigation of such phenomena as diffusion (*e.g.*, self-diffusion in metals), exchange (*e.g.*, chemical exchange), phase transformation (*e.g.*, sublimation), and complex flow (*e.g.*, turbulent flow and multiphase flow). Neutrons will be provided for chemical analysis by the measurement of nuclear decay products resulting from neutron absorption. This latter technique is of extremely wide applicability and extends even to the analysis of anthropological artifacts.

Of particular importance among the basic processes to be studied is that of fission. Inadequate understanding of this process and lack of information on neutron yields still limits the design of fissile material breeding plants.

The NBSR will be a tank-type reactor using enriched fuel and heavy-water moderator. The initial operating level will approach 10 megawatts; fixed features will be designed to permit operation at 20 to 25 megawatts when additional cooling towers and heat exchangers are added. The initial operating power will provide an in-pile flux of 10^{14} neutrons per square centimeter per second.

High Voltage Accelerator

A new design of high-voltage machine for accelerating atomic particles up to energies of 20 million electron volts, the first of its kind in the world, is to be part of a new atomic research center for Britain's Oxford University. The total cost of the installation will be about $3 million, and the project is the first of four stages in the construction of a new multimillion dollar home for the University's physics department—already the largest in Britain.

The new equipment will consist of a vertical 8- to 10-million-electron-volt Van de Graffe generator which can be used to feed high-speed particles into a 12-million-electron-volt horizontal Van de Graffe generator. Together the machines will be able to produce 10-million-volt particles at precisely controlled energies—making possible the study of nuclear restrictions in a whole range of known chemical elements.

The 12-million-volt horizontal electrostatic generator will be purchased from the United States. The vertical 10-million-volt electronic generator is to be designed and built by the electrostatic generator group of the National Institute for Research in Nuclear Science at Harwell, England.

Generator in Space

The tiny SNAP power generator fueled with plutonium 238 recently orbited in a Transit satellite is the first atomic power source to be used in space. It is a radioisotope-fueled device of the type first demonstrated by the U. S. Atomic Energy Commission in January 1959. With the benefit of experience gained from intensive experimental and analytical studies of the original proof-of-principle series, the generator operating in the Transit satellite has been fueled with a longer-lived isotope to give it the potential of continuous operation over many years.

(*Continued on p. 180*)

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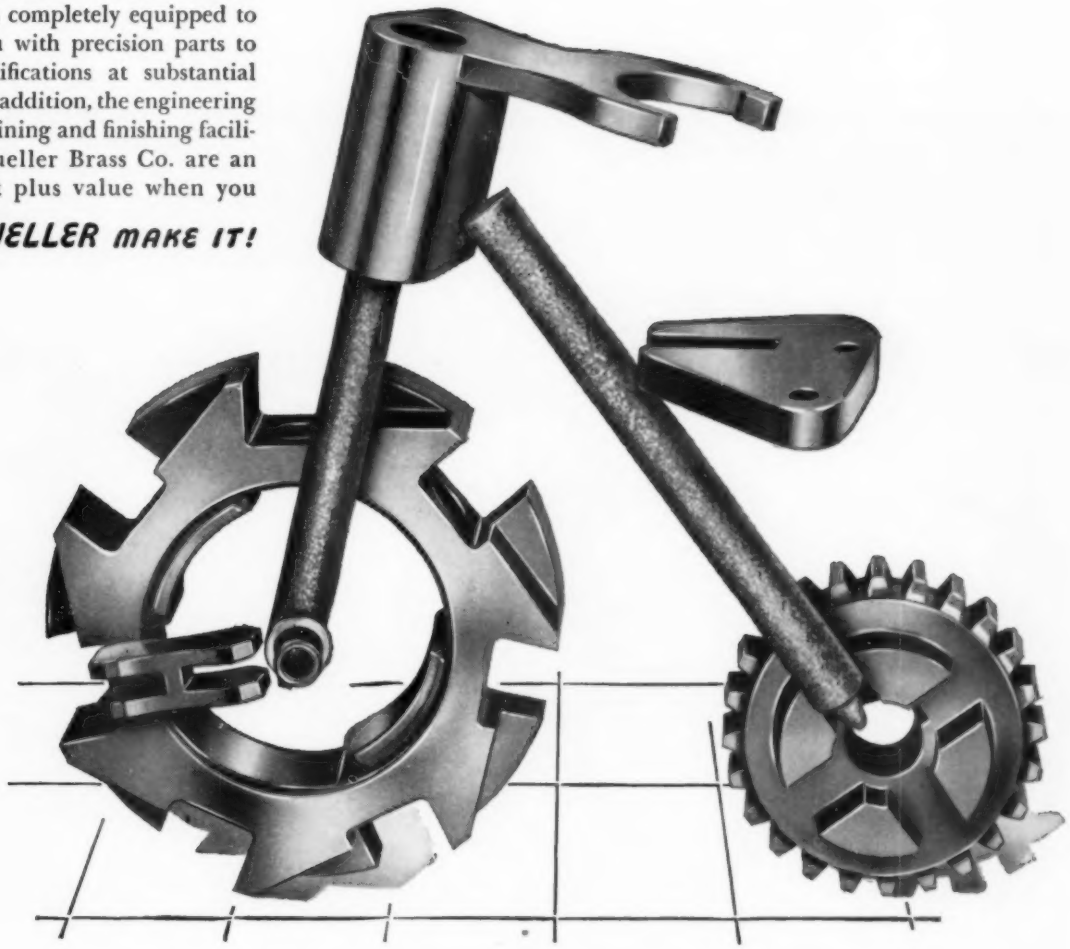

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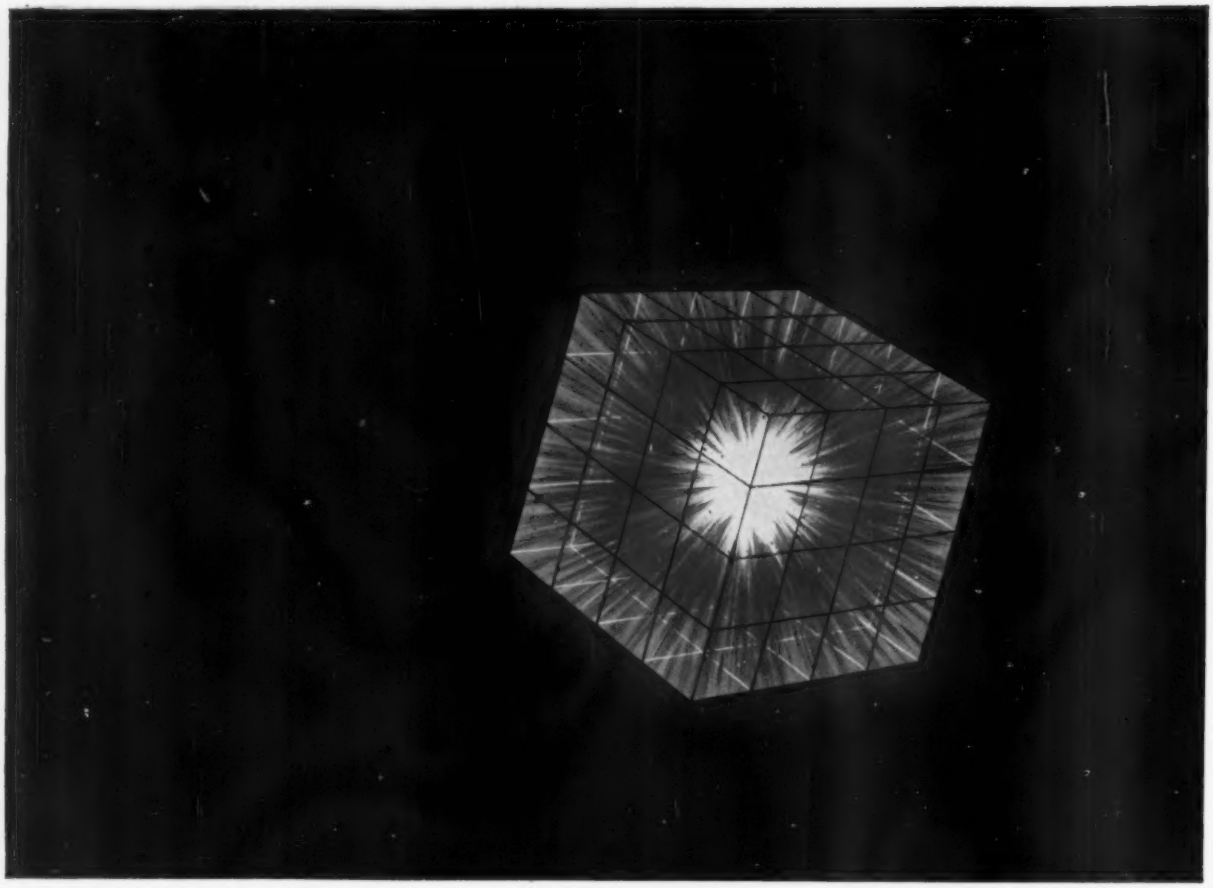

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Interested bidders should contact their
Only thirty days will be allowed for pre
tion is issued, so a preview of the pri

2. 1171 ALUMINUM FLOODLIGHTS --- Issued by
Chicago Corps of Engineers, 226 W. Jack
61-AF-448-JDB opening May 2, 1961 ---

3. 1500 PAIRS ALUMINUM CRUTCHES --- Issue
Illinois --- Bid No. M-3-39 opening M
wooden arm and hand pieces, adjust.

4. 570 MOUNTING PLATES FOR SAFETY AND AR
(T45E1) WARHEADS --- Issued by ORDNAI
IFB-ORD-11-173-61-18B -- opening May
processing, drilling and wiring. De
Iowa --- Requests for invitations f
1961. Bids will not be mailed to f
Small Business Only.

5. 490 RING AND SHELL ASSEMBLIES ---
DEPOT, Crane, Indiana --- IFT 164-
tooling available.

6. 1044 - 200 GALLON WING TANK ASSEM
TANK ASSEMBLIES --- Issued by CON
Force Base, California --- RFP S
104 aircraft --- At least 100,00
times larger than this figure --
McClellan AFB, California, on A
sould advise Directorate of Pro
Information may be submitted by
Sacramento, Calif. Further dat
proposal are not available, bu

Would you like to receive these exclusive sales leads for defense projects requiring aluminum?

The information you see here is available from no other single source. It is compiled and issued weekly by our nationwide defense staff—among all aluminum suppliers, first in knowledge of this important market.

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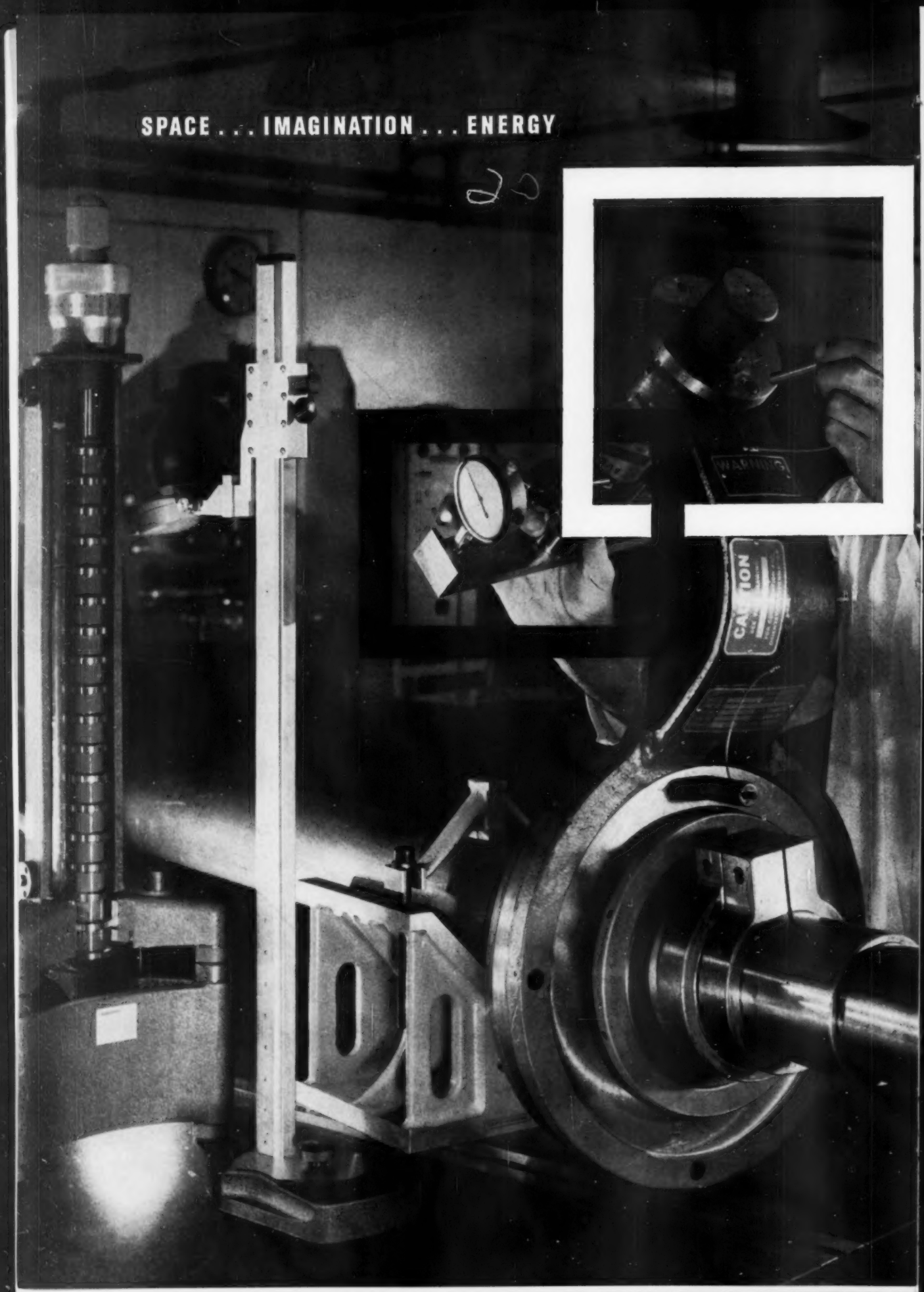
SPACE . . . IMAGINATION . . . ENERGY

Millionth-Inch Accuracies For Million-Mile Journeys

The Primary Standards Laboratory at Hercules' Bacchus plant has a fundamental accuracy of four one-millionths of an inch. This is second order only to the National Bureau of Standards in Washington. Here is the calibration point for all measuring, gaging, machining, and assembly of the third-stage motor for Minuteman, the advanced second-stage motor for Polaris, and in development of the ultraprecision retrorocket for Ranger.

There is good reason for such stringent physical accuracy. Missiles or space vehicles—whether they are to travel hundreds or thousands of miles, or into far distance—must traject with pin-point precision. And, unless the final stage is manned, or under cybernetic control, the governors of its final course are purely ballistic: the force, time, and direction with which its motor was originally endowed.

The factors of force and time are subject to chemical prediction; precision and dependability in this area are the backbone of Hercules' current contributions to missilry. Direction of application, however, is a purely physical thing, and calls for new orders of accuracy in manufacture. It is for this reason that the Primary Standards Laboratory at Bacchus is one of the key units of the Chemical Propulsion Division.

Chemical Propulsion Division
HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower—910 Market St., Wilmington 99, Del.

XP61-3

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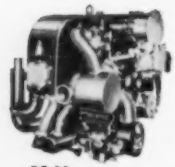
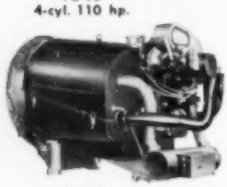
USE-PROVED
Round the Globe



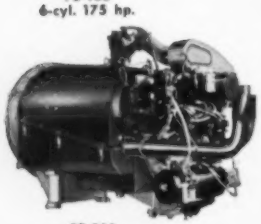
PC-30
2-cyl. 34 hp.

PC-60
4-cyl. 70 h.p.

PE-90
4-cyl. 110 hp.



PE-150
6-cyl. 175 hp.



PE-200
8-cyl. 250 hp.

Ground support equipment built around Packette power is proving itself today on defense installations all over the free world.

Developed by Continental Motors, with the famous Continental air-cooled aircraft engines as their basis, these five Military Standard models [Mil. E-26248 (USAF)] range from 30 to 250 hp, combine compactness and light weight with ease of servicing and upkeep, and operate at any temperature from equatorial heat to polar cold. Of special interest and importance, as simplifying maintenance in the field, is the wide interchangeability of parts among the several Packettes, and between them and the models in the Continental aircraft engine line.

They're use-proved NOW in air conditioners, compressors, crash trucks, generators, test stands, refuelers, heaters, blowers, Rollagons, multi-purpose tugs and other applications. Experience is proving: IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER ENGINE WILL DO THE JOB SO WELL.

WRITE FOR COMPLETE INFORMATION

Continental Motors Corporation
AIRCRAFT ENGINE DIVISION
MUSKEGON • MICHIGAN

Atomic Energy (Contd.)

The low-powered, lightweight, rugged, radioisotope-fueled thermoelectric generator converts directly into useful electrical power the heat produced by radioisotope decay. It contains no moving parts.

The generator was designed, developed, and built for the U. S. Atomic Energy Commission by the Nuclear Division of the Martin Company, Baltimore, Md. The fuel core was loaded by the Commission's Mound Laboratory, Miamisburg, Ohio, operated by the Monsanto Chemical Company.

The device is being used on the Transit satellite to power two of the experimental Doppler-frequency navigational signal transmitters.

The generator is roughly spherical in shape and is approximately 5 inches in diameter and 5.5 inches high. Its housing is a copper shell with a white coating which increases the ability of the generator to rid itself of excess heat through radiation in space and also cuts down the amount of heat energy absorbed from the sun's rays. The radioisotopic fuel is contained in a rugged capsule in the center of the sphere.

More Fission Products

The Atomic Energy Commission is preparing to make larger quantities of useful fission products available to industry for final processing and fabricating into "nuclear batteries" and other devices.

Fission products are radioactive isotopes found in the wastes generated in processing "spent" nuclear reactor fuel for recovery of the unused source and special nuclear material. Chief among the fission products to be made available are strontium 90, cesium 137, and cerium 144. These products are presently available from the AEC's Oak Ridge National Laboratory in limited quantities.

In order to supply the larger quantities expected to be needed in the future, the Commission is setting up recovery facilities as part of its Hanford, Wash., operations. ORNL will continue to operate its fission-product recovery plant to meet specialized requirements.

Present plans would enable the Commission to supply fission products in refined chemical form in megacurie quantities beginning about mid-1963.

The isolated fission product compounds will be offered for sale to private companies interested in final processing of the material, fabricating it into finished products, and developing useful applications.

Power Plant for Antarctic

The AEC is inviting industry proposals for providing a portable nuclear power plant for the Byrd Station in the Antarctic. The plant, designated PL-3, would be the second of the reactors for the Ant-

PROJECT HEAT

FOR MILITARY APPLICATIONS

In cooperation with research and engineering commands of the U.S. Armed Forces, Hunter Manufacturing Co. for more than twenty years has specialized in the design, development and manufacture of multi-fuel-burning heating systems.

Hunter heating systems with *sealed-in-steel* combustion are employed for a wide variety of military uses—for space and personnel heating in mobile shelters, in portable or fixed structures of many different types, in self-propelled vehicles, in ground support systems for missiles, in radar and microwave systems, etc.

Other types of Hunter systems are widely used in winterization operations, for engine pre-heating, for emergency heating requirements and for many other using arm operations. Hunter heating systems are designed for cold starts down to 65° below zero and are air-circulating in type with thermostatic controls. Uncontaminated heat capacities range from 15,000 to 300,000 BTU/hour.

If you have a problem involving the application of heat, Hunter can help you solve it.

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Look again, there's not a speck in the sky . . . and yet all day long training crews have been "launching" one Sergeant after another. The Sergeant handling and checkout trainer, developed and now being produced by AAI, allows missile crews to assemble . . . erect . . . check out . . . monitor . . . count down and "fire" without a missile ever leaving the ground. This is another achievement by America's most experienced designer and manufacturer of training, test and simulation systems.

AIRCRAFT ARMAMENTS, INC.
COCKEYSVILLE, MARYLAND

AAI

Developers of training and test equipment for:
Sergeant, Redstone, Atlas, Polaris, Nike, Sparrow, Titan, and Terrier Missiles

arctic authorized by the Congress in 1960. The Commission is currently procuring for the Navy a nuclear power plant for operation at McMurdo Sound in 1962.

The PL-3 will be used to provide electric power and steam for the station which is a base for studies supported by the National Science Foundation. The steam produced would be used to operate snow-melting equipment designed to provide an ample supply of fresh water at the site.

The plant would be assembled in modules suitable for air transport in a C-130 plane from McMurdo Sound to a remote inland site. Shipment to McMurdo Sound from the United States would be by ocean transport, scheduled for late 1963.

The nuclear plant would be powered by a light water-cooled and -moderated reactor of either the forced-circulation, pressurized-water type, or the natural-circulation, boiling-water type, and would be fueled with enriched uranium. It would be designed to facilitate relocation with minimum effort during its 20-year anticipated life.

Nuclear Ship Progress

The Atomic Energy Commission recently authorized fueling, start-up, and operation of the reactor of the N. S. SAVANNAH, the world's first nuclear cargo-passenger ship, for test and demonstration purposes at Camden, N. J., and Yorktown, Va., and for initial sea trials of the vessel.

Construction of the SAVANNAH was authorized by Congress in 1956 as a joint project of the U. S. Atomic Energy Commission and the Maritime Administration of the U. S. Department of Commerce. The primary purpose in building the SAVANNAH has been to produce a prototype vessel which would serve as a forerunner of other commercial nuclear vessels and as a test facility to permit the development of improved components and techniques for nuclear ship operation.

The action of the Commission covers five phases of testing and initial operation of the SAVANNAH. These are tests to determine the adequacy of construction and installation of machinery, components, wiring, and piping (Phase I); a "dummy run" in which all reactor systems were operated concurrently without the use of nuclear fuel (Phase II); loading of fuel elements and concurrent testing at the shipyard of the New York Shipbuilding Corporation (Phase III); progression from zero power to operation at not more than 10 per cent full power at the Camden location and, after transfer of the ship with the reactor shut down from Camden to a site on the York River near Yorktown, Va., completion of dock trials up to full power (Phase IV); and sea trials off Virginia by the builder with Yorktown as an operating base (Phase V).

PROVEN IN FLIGHT...Fairchild Programmers, Fuzes, Safety and Arming Devices

Ordnance products furnished by the Defense Products Division are answering our nation's urgent need for reliable, sophisticated systems and components. Integral programmers, missile fuzing, safety and arming devices, mechanical and electronic timing systems are designed and produced for special environmental requirements to close tolerances. The rugged, transistorized, lightweight programmers are performing vital control functions in current satellite projects. Fairchild fuzes, also in operational use, are precision designed for high reliability application in surface-to-surface, air-to-air and air-to-ground weapons. Safety and arming devices for long-range ballistic missiles have been successfully developed and produced in quantity. For further information on how this capability can fulfill your ordnance requirements, write the Director of Marketing, Defense Products Division.

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CAMERA AND INSTRUMENT CORPORATION

DEFENSE PRODUCTS DIVISION
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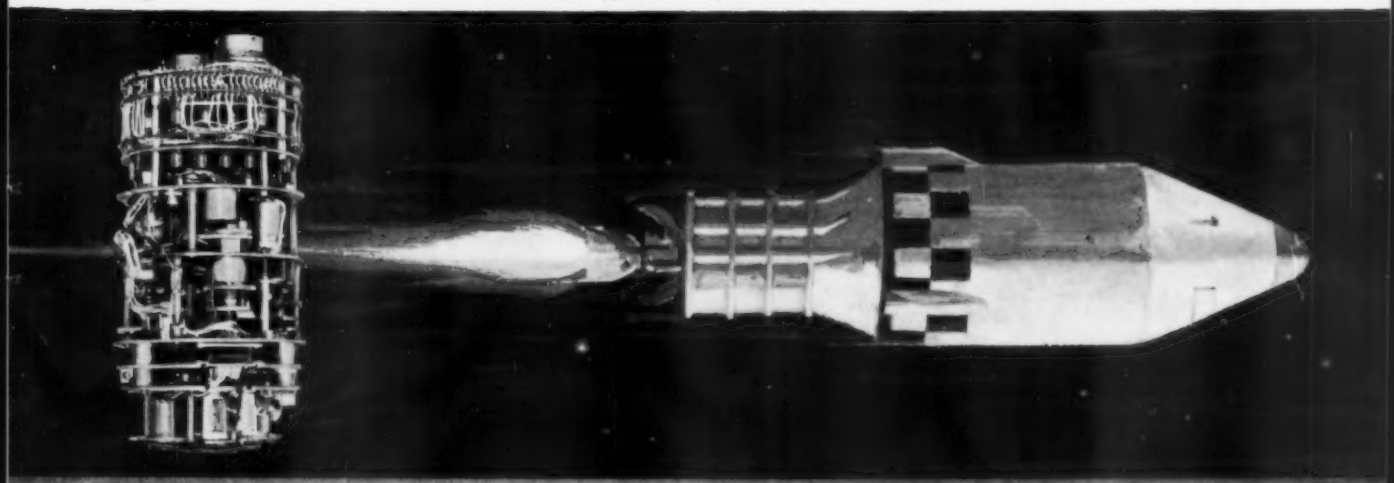
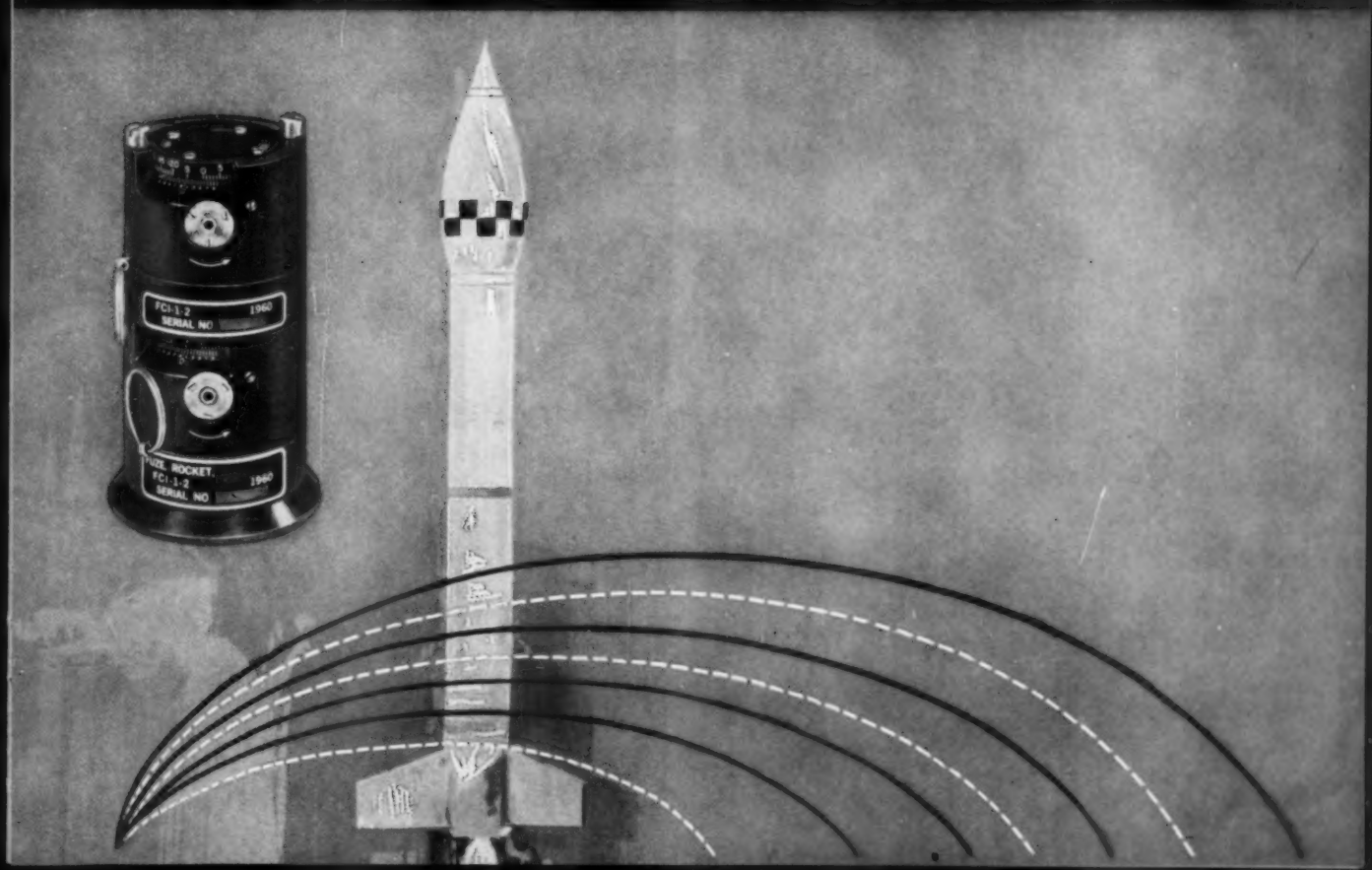
Engineers and scientists are invited to discuss new opportunities presented by continuing growth of the Defense Products Division.





Almost all military forces count their strength in

systems using Sperry electronic tubes

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ELECTRONIC
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The GOER is a diesel-powered two-wheeled prime-mover to which a variety of interchangeable trailing units having rear-wheel power may be attached. Shown is a multi-purpose cargo unit. Monocoque construction of prime-mover and trail body provides flotation to support the loaded machines in water and enables GOER to negotiate inland lakes and rivers.

This Army transport "SWIMS" across rivers and lakes

...and, *on land* it travels over ditches, boulders, logs, and other obstacles ... works its way through treacherous mud, snow and sand. It's the U.S. Army GOER.

Mobile and agile, the GOER is easily adaptable to many types of military transport assignments. It is a product of the Development and Production Engineering Division of LeTourneau-Westinghouse Company, who collaborated with United States Army personnel under the jurisdiction of OTAC, Detroit Tank Arsenal.

When you need help on major product development, consider these facilities available to you at LeTourneau-Westinghouse:

1. More than 500 scientifically trained men of diversified talents, many with extensive experience on military assignments.
2. Over two million square feet of plant area, specially tooled to produce wheeled transport, lifting, earthmoving and grading equipment.
3. World-wide distribution — assurance of service and parts facilities anywhere.
4. *LW is also available on subcontract basis*, anytime assistance is needed in the manufacture of component parts. Expert workmanship in metal fabricating and scientific methods of quality-control assure you of a product or component that meets your exact specifications.

For complete information, please write or call collect any one of the offices listed below.

In addition to the multi-purpose cargo unit and fuel tank shown here, other trailing units can be designed as missile carriers, mobile surgeries, mobile command posts, mobile signal stations, field kitchens and service shops. For "outstanding engineering development of the GOER vehicle," *Ground Support Equipment* magazine presented LeTourneau-Westinghouse with the 1960 "GSE award."

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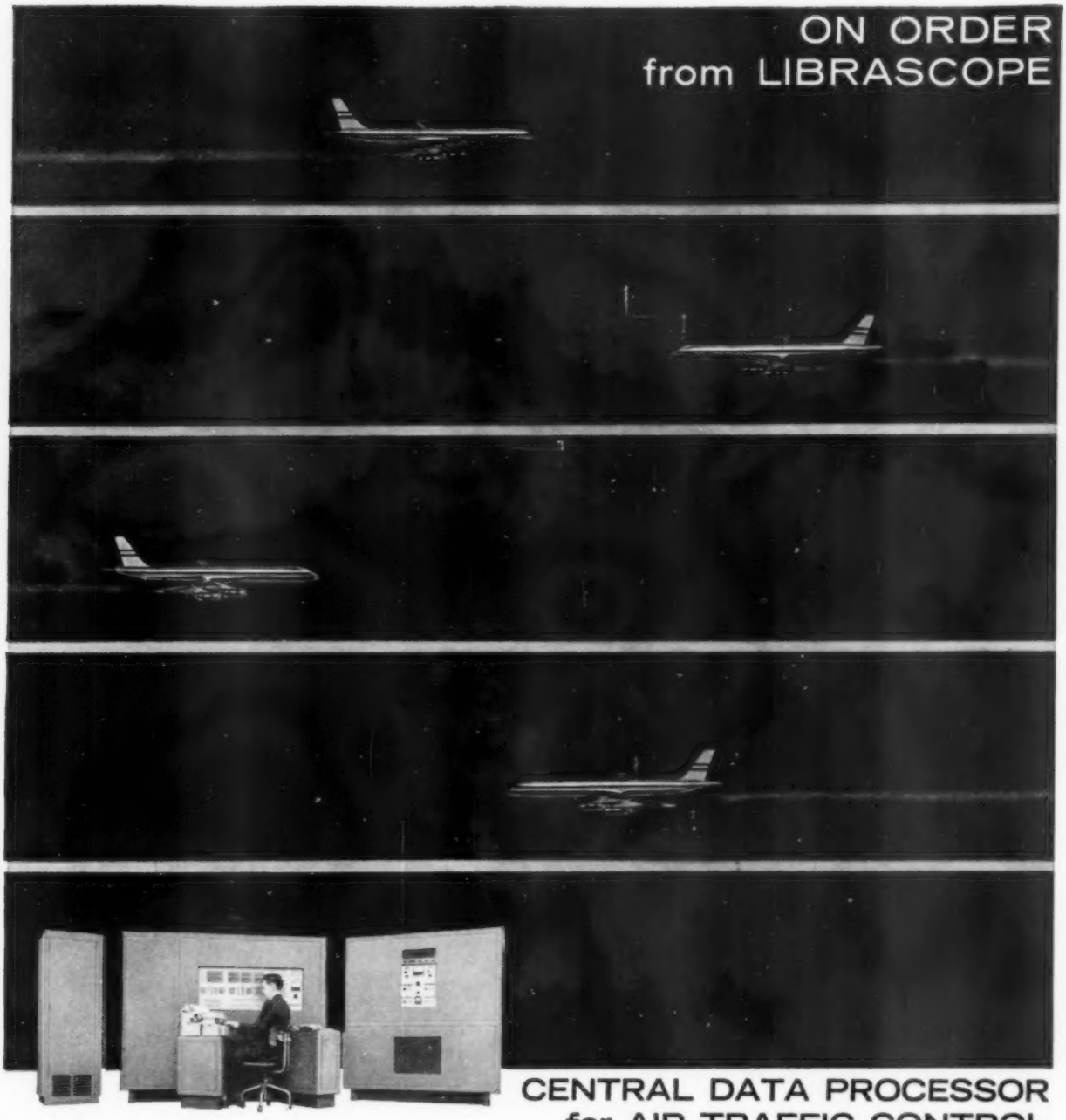

CENTRAL DATA PROCESSOR for AIR TRAFFIC CONTROL

Today, at a peak traffic hour, approximately 200 aircraft flew over the New York area. Each year this number will increase. Yet, the Federal Aviation Agency will continue to assure safe and efficient control of air traffic. One reason . . . a data processor developed for the FAA by Librascope to quickly and accurately handle the routine clerical tasks now occupying most of the controller's time. The first 18-unit data processor will be installed at Boston in 1962. A note to Librascope outlining your control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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STOP THAT MISSILE-
AND THE NEXT ONE TOO!

In probing uncharted areas of electronics to solve the critical anti-missile problem, our scientists and engineers have developed advanced early warning systems of vital significance to national security.

For example, our work on ballistic missile defense systems has led to the development of a unique method for performing a great many dissimilar radar functions simultaneously and from one antenna. This technique —known as multifunction phased array radar—allows one advanced radar to replace many conventional radars. It permits long-range detection and selective tracking and targeting of numbers of small high-speed objects, including satellites, other space vehicles, missiles and warheads.

Since tracking beams can be positioned in a *fraction of a microsecond,* it is possible to track a great many targets while continuously searching for additional missile threats. And because phased array radar beams are electronically steered, the antennas do not rotate; and there is no chance for mechanical failure.

Major advances such as phased array radar are typical of the work being done by the scientists and engineers of the entire General Telephone & Electronics corporate family. The vast communications and electronics capabilities of GT&E, directed through Sylvania Electronic Systems, can research, design, produce, install and service complete systems. These include the entire range from detection and tracking, electronic warfare, intelligence and reconnaissance through communications, data processing and display.

That is why we say—the many worlds of defense electronics meet at Sylvania Electronic Systems, division of Sylvania Electric Products Inc., 40 Sylvan Road, Waltham 54, Massachusetts.

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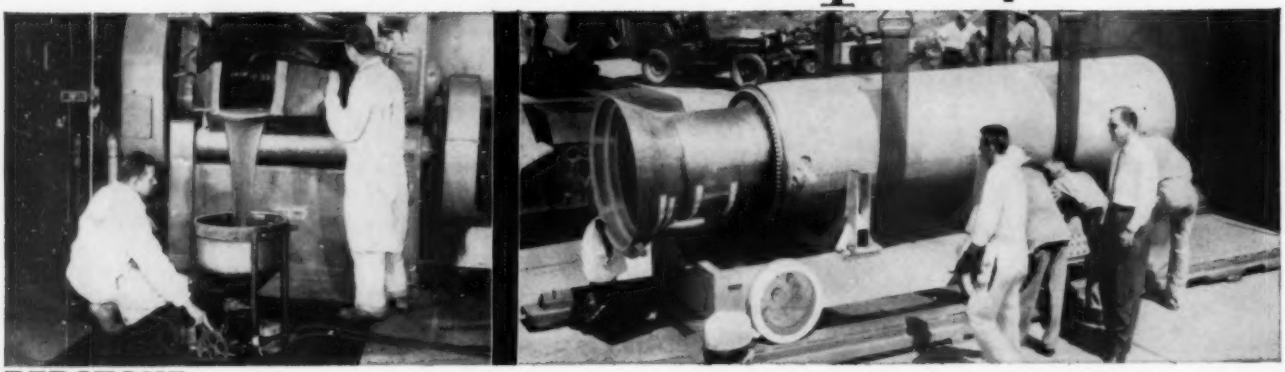
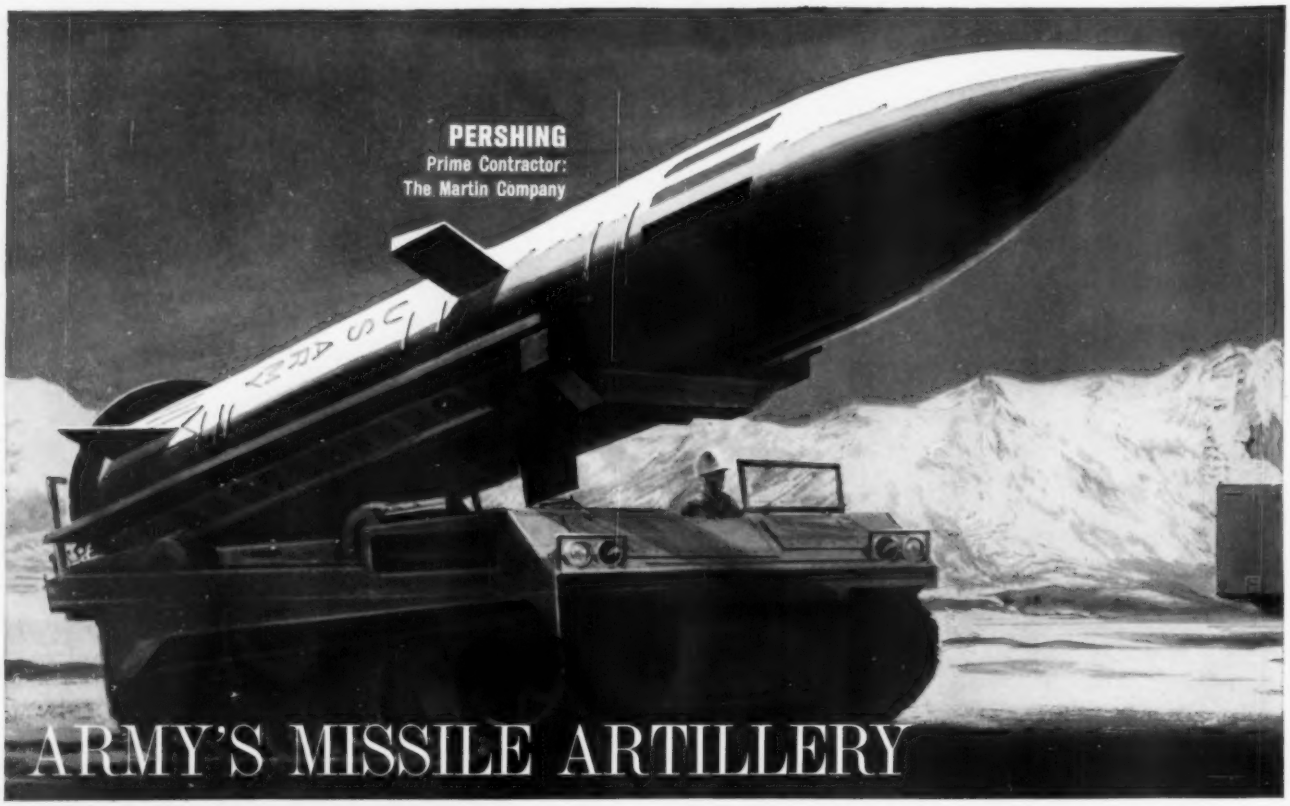


REDSTONE *Working as part of Army's Ordnance team, Thiokol's Redstone Division conducts research into propellant formulation and solid propellant motor development. Experiences—gained in the labs, through developing prototype engines, and at firing bays continuous since 1949—have resulted in many significant breakthroughs . . . providing a steady increase in size, thrust and performance of solid rocket motors.*

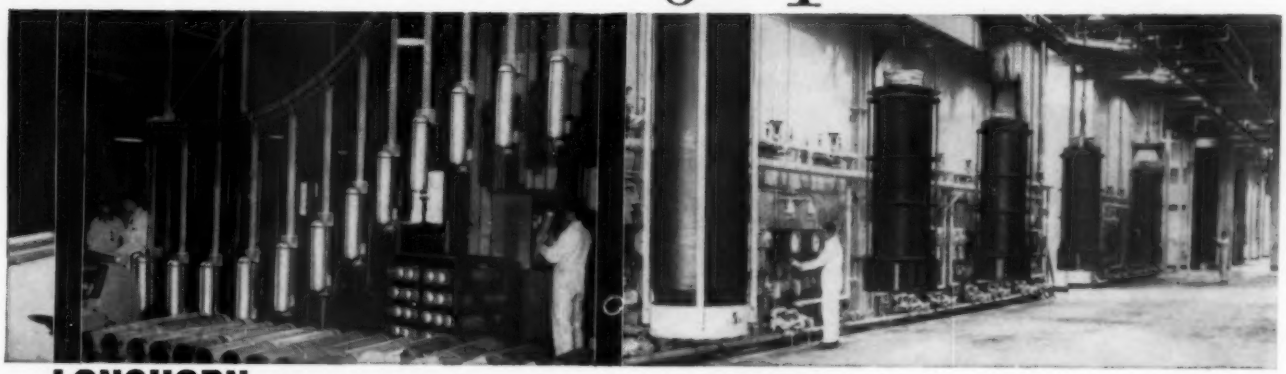


ARMY'S MISSILE ARTILLERY

ARMY

In close cooperation with the Army and prime contractors . . . Thiokol designs, develops and produces propulsion systems in wide variety to meet the most stringent military requirements. The associations are distinguished by a series of major breakthroughs in propulsion engineering—beginning with small rocket motors for tactical field use and carrying through to massive powerplants for anti-missile and satellite application. All have checked out in static firings and

research through production



LONGHORN *Motors for the Lacrosse and for the developmental Sergeant and Pershing missiles, and for other major systems—all boasting remarkably high reliability scores—move into smooth mass production at Longhorn. Incorporating most advanced methods of manufacture and quality control, Longhorn's total productive capability has yet to be challenged. Other Thiokol Divisions provide additional scientific and production capabilities.*

flight tests with virtually 100% reliability. All have contributed mightily to advancing the total state of the art. Additional capabilities for Army's advanced thinking are provided by other Thiokol Divisions. Utah, for large engine production—RMD, for sophisticated liquid systems — and Elkton, for diversified special motors.

Through fluid programming of assignments, and strategic enlargement of facilities for research, development and production, Thiokol maintains a live capability to meet any current and future propulsion challenge — military or space.

THIOKOL

THIOKOL CHEMICAL CORPORATION, Bristol, Pennsylvania
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This mark tells you a product is made of modern, dependable Steel.

What would you call pressure bottles shaped like this? You'd call them hot dogs? That's the name we picked out for the new curved pressure bottles we make at National Tube. Some of our engineers don't agree with the name—it doesn't suggest how strong these bottles really are. They are so strong they can withstand pressures as high as 20,000 psi. All USS National Seamless Steel Bottles, curved or straight, are pierced from solid, white-hot billets of high quality steel—carbon, alloy or stainless. The walls, up to 3 inches thick, contain these extreme pressures at temperatures ranging from minus 320F. to 1,000F. We can curve these bottles to fit almost anywhere. The Navy's new missile carrying submarines use USS National Shaped Pressure Bottles to eliminate wasted space. If you're interested in a perfect container for storing, transporting or handling high pressure liquids or gases, write for Bulletin 25. National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. USS and National are registered trademarks.

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Air Force photo

GEN. CURTIS E. LEMAY

Chief of Staff, United States Air Force

Aerospace Supremacy

The primary mission of the United States Air Force in war or peace

THE United States is in a technological era where the pressure of time, while never a stranger, is never an ally. This era is one in which the need has never been greater for seasoned military leaders who make sound decisions with confidence and mature judgment based on a broad base of experience.

Gen. Curtis Emerson LeMay, the new Chief of Staff of the Air Force, is this type of leader—a man of proven vision and courage, a man both practical and bold.

The Air Force he heads today has as its medium of operation the vast expanse of air and space. Small wonder it is in a constant period of change as weapon systems become more complicated and costly and the need for quality personnel grows more pressing each year.

Faced with the critical need for constant development of new weapon systems, acquisition of superior in-being systems, and modernization of existing systems, the Air Force has been forced to modify, even discard, the old concepts of defense planning.

Technology has compressed time to such extremes that systems in the development and test stage are threatened with obsolescence before they are operational, unless a program of concurrency is carried forward.

The intercontinental ballistic missile program offers some striking examples of the result of the time compression.

The new Chief of Staff of the United States Air Force, 54-year-old Gen. Curtis E. LeMay, is a renowned combat commander and military manager.

In November the Columbus, Ohio, native will complete thirty-three years of service, over half of which he has served as a general officer, the rank he achieved at the age of 36 while commanding the 3rd Air Division, Eighth Air Force. Already famed for his daring use of new bombardment techniques, he led the first shuttle raid which started in England, struck Regensberg, and landed in North Africa.

Ordered to the Pacific to command the B-29 units in the China-Burma-India Theater, he was soon promoted to major general. At 37 he was one of the youngest men to hold that rank in the Army.

General LeMay earned a permanent place in history with the dramatic decision to send Superfortresses in at low level to strike Japanese targets. He was Chief of Staff of the Strategic Air Forces in the Pacific when the two atomic bombs were dropped.

A civil-engineering graduate from Ohio State, he fathered the present-day missile force while assigned as AAF Deputy Chief for Research and Development.

Commanding USAFE in 1947, he organized the Berlin Airlift. Returning to the United States in 1948, he took command of the embryo Strategic Air Command. His managerial ability was proved when in a few years he organized and trained what is acclaimed by many as the mightiest professional military force in the history of man.

USAF Vice Chief for four years, he became Chief of Staff on July 1st of this year.

AIRMEN always have been in the vanguard of visionaries. Yet today they find themselves in a strange, sometimes incongruous position. The Air Force urges leapfrogging in development and procurement of new and exotic weapon systems while in the same breath it recommends against premature discarding of the current and proven systems. Parallel development of manned and unmanned weapon systems while maintaining combat capability is the Air Force's formula for national defense.

The Air Force has made its concept of future strategy and the weapon systems required quite clear. With the Nation confronted by a long-range, unrelenting threat, the Air Force view is that only a strong diversified force can ensure maximum destruction of in-being weapons poised to destroy the free world.

This calls for a mixed force of manned and unmanned systems—a careful blend of weapons having a war-fighting and war-winning capability.

THE Air Force's primary mission, even as it moves farther out into space, is the gaining and maintaining of aerospace supremacy over an aggressor through the realm of all possible degrees of conflict.

Mission performance remains uppermost in the minds of men like General LeMay. This requires the selection of the best weapon systems—regardless of any emotional relationship to the traditional weapons of war. By combining the best features of manned and unmanned systems, defense planners can guarantee the best possible capability, capitalizing on the strong points of each, and using each to complement and fill in the weak points of the other.

The American Ordnance Association has always advocated the degree of preparedness that will ensure peace not only today but in the future. The days ahead call for the finest in leadership, the greatest of dedication from all Americans, and the staunchest of wills to stand firm. General LeMay typifies such leadership. He has become a symbol of the will to stand firm.

A Single Supply Service?

Mark S. Watson

DEMOCRACY ought to be efficient enough to discern its own weak spots before either an enemy or a well-meaning friend puts his finger on them, but, unhappily, it very often fails to see them in time. Of this, Cuba provided a mortifying example, although the Cuban fiasco, for all its doleful aspects, carried a few compensations, if one is industrious enough to ferret them out. The most salutary, if certainly not the most comforting, was the clear evidence that radical improvements and outright reforms were necessary in several areas of our Government's most important functioning.

Could it have been worse? The answer is obviously, Yes! At a modest cost in everything except self-esteem, the United States had enough of a slap to awaken it thoroughly to deficiencies of intelligence and appraisal and programming and decision. Such an awakening might have come later, and with far more serious results.

So much is fairly obvious. There is another salutary result, less obvious because less immediate, and also less dramatic. This is an odd rebound, which hardly could have been predicted by any save a major prophet. For the military chiefs who at the outset came in for some most unwarranted amateur criticism because of their fancied "responsibility" for the wretched Cuban operation, and whose own stiff sense of discipline forbade their making any direct reply, soon found defenders.

This does not refer to the President's wry confession that in the Cuban business there was "blame enough for all" but to the much more significant public declarations of satisfaction and pride in the Joint Chiefs of Staff which came voluntarily and in timely manner from the President, the the Secretary of Defense, and the Deputy Secretary.

The fact is that proud declarations of this sort were of special timeliness, for causes unrelated to the Caribbean. The several reorganizations of national-defense machinery, mostly beneficial, have been marked by a growing tendency to downgrade the authority of the career military professionals in favor of the new, short-term civilian administrators.

THE civilian control of defense matters is not at issue; that is assured by the Constitution, by statute, by Executive and Legislative conviction, and by public attitude. The question is solely of the civilian official's controls reaching down into operating areas where professional knowledge and experience are essential to accurate thinking and effective performance.

It is hardly deniable that for some years there has been a tendency on the part of civilian Secretaries and deputies and assistants, of proved expertness in administration of large nonmilitary affairs, to assume an equal grasp of military affairs which, quite plainly, is not

immediately acquirable by osmosis nor effected by directive.

AS a result, under centralization at the Pentagon there has been a great deal of taking over of decisions and actual operations for, although Secretary Forrestal came into office with a concept of "policy-only" administration—of coordination rather than operation, and the use of a very small staff—Secretary Forrestal's successors usually had grander ideas. Particularly since the great influx of civilian secretarial assistants and deputies under Secretary Charles E. Wilson, each with a praiseworthy desire to work at his task, there has been a great deal of taking over of decisions and, more unfortunately, of actual technical operations.

In areas where there was special competence, there often have come good results, some of which will be mentioned hereafter. Some have been dubious, and further extensions now under active consideration are so disturbing that they call for scrutiny.

There is particular reference here to consolidations of supply operations, theoretically justified by several grand-scale, single-management operations in appropriate fields of endeavor which have turned out very well indeed. The peril lies in an extension of this endeavor into fields not appropriate to that sort of reorganization and operation.

At present writing one can speak only of possibilities rather than realities, for an Army task force is still exploring the possibilities of reorganizing, if not actually consolidating, the Technical Services, perhaps under a Logistics Command. The study, still incomplete, springs from a Defense Department belief that both economy and efficiency can be brought about by a stronger control of those activities through which is channeled the great bulk of the Army's procurement monies and of its research and development monies as well. Hence the directive to the Army to initiate a study and the Army's thoroughgoing examination of possibilities.

The background for all this must be understood. There has been a wave of centralization, with notable consolidations of hitherto separate activities. In December 1959, for example, the Navy brought together its old Bureau of Aeronautics and Bureau of Ordnance into a new Bureau of Naval Weapons. Changing technologies hastened that step, which had been under contemplation for some time as a means of shortening lead-time in delivery of a whole weapons system, as distinguished from delivering several separate combat instruments.

This past winter the Air Force combined major aspects of its Air Matériel Command and its Research and Development Command into a new Air Force Systems Command, with much the same purpose. From this reorganization emerged also the new Air Force Logistics Command, retaining the purely logistical function of the old AMC. This latter creation quite clearly raised a question of whether Army logistics, despite their much greater diversity, could be similarly rolled into one large package.

In the background there also is the record of "single-management" operations of recent years, which at first glance seem to encourage further operations of like character. Common purchases, where service needs were identical or nearly so, have been developed over the years, but in 1955 the Hoover Commission of that period went much further, proposing that a large part of logistics be taken away from the armed services altogether and vested in a separate civilian agency (reporting to the Secretary of Defense) which would administer a common supply service for Army, Navy, and Air Force alike.

Significantly, the recommendation was not unanimous. And it was not supported either by the Secretary of Defense or by the White House, quite possibly by reason of a devastating criticism by the Army's Deputy Chief of Staff for Logistics, dated September 26, 1955, of which more will be said hereafter. Yet five years later, in October 1960, and on much the same reasoning, the (Douglas) Joint Economic Committee reached the conclusion that over two billions a year could be saved by setting up a common supply agency vested with powers to determine needs and perform functions of procurement, storage, transportation, and issue.

AN ingenuous admission by writers of that recommendation was that they had not concerned themselves with matters of military strategy, weapons, or tactics. Perkins McGuire, then an Assistant Secretary of Defense, promptly pointed out that logistics is integral to defense and that supply planning must therefore be compatible with military functions. He may have recalled the Army document of September 1955, just mentioned.

What the Defense Department actually devised in 1955-1956 was a single-manager plan, large in scope but very definitely limited. It broke up into manageable segments those supply activities in which the Defense Department's administrators' own professional skill could provide intensive management effectively. Thus, the Army in 1955 became the single manager for subsistence purchases and in 1956 for clothing and textiles and later for traffic management; the Navy for medical supplies, petroleum products, and ocean transport; the Air Force for airlift.

Studies were initiated looking toward extension of this principle by 1963 to general supplies, construction supplies, automotive supplies, and industrial supplies, and possibly further extensions. A single manager, it should be explained, owns and manages inventories, procures, stores, and directs distribution. He gets from Army, Navy, and Air Force, respectively, a statement of each service's requirements and tech-

A well-known military analyst of the Baltimore *Sun*, Mr. Watson was honored recently by the Department of Defense. At a news conference in the Pentagon, Defense Secretary McNamara cited him for his years of reporting with intensive perception and analysis the activities of the armed forces of the United States.

A Pulitzer Prize winner, Mr. Watson is a frequent contributor to these pages. The editors of ORDNANCE applaud this well-deserved tribute to "a distinguished military correspondent, historian, and scholar."

nical advice, and leaves to them the actual distribution.

These single-management operations have justified themselves, by efficiency quite as much as by dollar economy. Defense Logistics tabulations indicate that in 1957 there were some 40,000 back orders in clothing and textiles; latterly there were fewer than 1,000. In supplies generally, it is reported, there was a vast crisscross of haulings and multiple storage in 58 locations. The locations now are reduced to 11, and the space requirement has been reduced by 5,900,000 square feet at an estimated annual saving of $3,500,000.

THE reduction of separate items effected a first-time saving of $10,500,000. Personnel reductions indicate a $5,500,000 annual saving. Inventory reduction brought a one-time saving of $509,000,000. More important perhaps was a reduction of the administrative processing time, for the "delinquency rate" (contractor delays of 30 days or more) was cut by as much as 90 per cent.

A grand total arrived at by Defense Logistics is that $20,400,000 represents the annual savings, atop a one-time saving of $521,500,000. This is effected in storage space, payroll, inspection, and procurement and distribution. And the end is not yet, for where the single-management process seems to give further promise, there presumably will be further extension.

But it is significant that Defense authorities most experienced in single-management activities recognize that not all supply work is susceptible to such handling. Mr. McGuire's succinct statement explains why, and the methodical Army study now being carried on under direction of Deputy Comptroller L. W. Hoelscher is fully in line with the principles laid down by the Deputy Chief of Staff for Logistics in 1955.

Few in today's Army are familiar with it. Because it was so blunt a rejection of the Hoover Commission's concept of a civilian supply agency for all armed services, and because it is as sound today as it was six years ago, direct quotation of some of its main points seems warranted.

"It is significant that Defense authorities most experienced in single-management activities recognize that not all supply work is susceptible to such handling."

"Notes on a Fourth Service of Supply and Alternatives" opens with a statement of the mission of the Army, quoted from President Truman's Executive Order 9877, of July 26, 1947: "To maintain by timely and effective military action the security of the United States, its possessions and areas vital to its interests." To this end all else must be directed, and accordingly the Notes offer a thoroughgoing analysis of what a new civilian supply group, however efficient, would do to the Army's permanent organization which is set up primarily for war. Thus:

"IT is estimated that creation of the new agency and transfer of the medical and service functions considered would reduce the Army Medical Service to approximately 15 per cent of its size under current peacetime or wartime conditions . . . The Quartermaster Corps would be reduced to approximately 5 per cent of its current size or of its normal size in wartime . . . The Ordnance Corps would be reduced to about 85 per cent of its service, training, and supply activities . . . The Engineer Corps to some 15 per cent . . . The Signal Corps to about 50 per cent . . . The Transportation Corps to not more than 25 per cent. . . .

"Preparedness is fundamental both to the combat forces and the logistical organization which supports them. Nothing that jeopardizes this preparedness can be considered economical despite how much money might be saved in the process. . . . Two elements are to be considered in appraising the Military Establishment—effectiveness and economy—and by far the more vital of these is effectiveness. Any new organization which is equally effective as the present one, but more economical, is of course desirable. On the other hand, any new organization, no matter how economical, which is less effective, is *not* desirable.

"The mission of the Defense Department lies far outside the boundaries of business. It exists to protect the United States against extinction by a hostile force. An Administration that used men and money economically, but that permitted military defeat, would be ultimate calamity." (This last is apparently quoted from Eugene S. Duffield.)

THERE is a quotation also from Brig. Gen. (later Lieut. Gen.) D. T. Booth when on the Joint Staff, in an August 28, 1951, memorandum to Gen. Charles Bolte: "I think it is important to emphasize that military supply operations must not be considered as an independent function to be made most efficient in its own right as an end in itself. Rather, supply operations and functions must be made most efficient only in the light of making supported forces more effective, even if this implies less economy or efficiency in the supply service itself. Supply is not an end in itself. It is a support service and must be viewed in that light."

The Logistics report, commenting with asperity on comparative efficiency in operations, says: "The Hoover Commission uses the phrase 'operated with the efficiency of a commercial enterprise' from which the inference can be drawn that a business organization is more efficient than a military. That is evident from the frequency with which 'business methods' are suggested as a panacea for whatever ills there may be in the military logistics system. . . . In fact, many methods used in business are fundamentally military methods. 'Wartime experience with techniques used by the military opened many businessmen's minds to the possibility of reorganizing their own command structures.' (This is a quotation from Perrin Stryker's "Can Management Be Managed" in *Fortune* magazine.)

"There is no commercial enterprise which, like a military department, is compelled to function efficiently in peacetime at perhaps ten per cent of its capacity, while trying at all times to keep its plant ready for instantaneous expansion to one hundred per cent production. American business would most likely not remain efficient amid such violent fluctuations. . . ."

The Notes contain a proud admission that "military agencies have been criticized for the . . . severity and rigidity of military specifications, close tolerances, extreme tests of strength and durability, and high rejection rates," and quote with satisfaction a Wall Street newsletter report then current, stating that "clerical salaries now amount to one-ninth of the Nation's total income. . . . It costs 20 cents to create one piece of business paper . . . and business is a worse offender than Government in the rising tide of paper work." Again from a current *Fortune* article is quoted: "Large corporations today do not utilize central service organizations. Of the first twenty-five (largest industries) listed only five use centralized procurement."

On this same theme, surprisingly, Charles E. Wilson (in 1949, before he left General Motors to move to the Pentagon) is quoted as saying: "If all the purchasing were done in one place we would have more people doing it and trying to keep a record of it and we would have less responsibility for what occurred."

LAWRENCE Livingston, when vice-president of the Continental Can Corporation (in World War II he was Gen. Lucius Clay's economic adviser) is thus quoted:

"A certain degree of detailed control by top management must be sacrificed in order to obtain speed and efficiency in field operations. The Army in the procurement field should press decentralization of authority, and simplicity, and uniformity of regulations as far as higher authority will permit. The present basic organization into seven procuring technical services with staff supervision by the director of logistics provides an excellent degree of decentralization."

The following excerpts from the Notes' argument are apposite:

"Mr. Baruch was urged to create a centralized procurement agency for military supplies in World War I. It was urged in World War II. In both instances it was rejected on the ground that there were many overriding advantages in decentralization. . . .

"Despite the claim that the 'Administration' would provide a supply system more quickly expandable in wartime, the military services are actually better prepared by training, organization, and existing law to accomplish the required expansion. . . .

"The 'Administration' would be required to expand its operations at a time when it was losing trained personnel to Selective Service, with both civilian industry and the military services making urgent demands on the available manpower supply. Exemption of 'Administration' personnel from military service would transform that organization into a haven for draft dodgers . . . not acceptable to Congress or the American people. . . . The Army, on the other hand, has reserved logistical-type units available for immediate call to active duty. . . . Expansion of the Army in World War II was a feat unequaled in history."

If some of these expressions are those of oversensitive professionals clearly stung by criticism from not overinformed sources, it may be observed that, far from standing pat on the existing program, the Notes recognized certain areas where there could be marked improvement. Specifically listed are these "recognized deficiencies" of that day:

1. Lack of unified inventory management practices.

2. Lack of standardization of accounting procedures, of documents, forms, and reports.

3. Need for more positive leadership by the Department of Defense; more specific directives, follow-up, active participation in programming the integration of the armed services.

4. Need for coordination between Army, Navy, and Air Force in determination of net requirements to reduce overbuying.

5. Uneconomical use of storage space.

"The civilian control of defense matters is not an issue; that is assured by the Constitution. . . . The question is solely of the civilian official's controls reaching down into operating areas where professional knowledge and experience are essential to accurate thinking and effective performance."

The 1955 list is interesting in two respects: (1) as showing the Logistics Office's readiness to admit where improvements in the Army's (and other services') logistics operations could be effected by Defense Department coordination and supervision, and (2) because in fact most of these suggestions were promptly accepted and now are in effect. The whole document is a tribute to the compilers' integrity as well as their wisdom. It also is a tribute to their industry, for the attached bibliography indicates a preparatory scrutiny of 124 reports on that subject.

Meritorious as it is, however, and well worth remembering, it affords melancholy evidence of how transient are good deeds in a naughty world of official papers—three researchers who, above almost everyone else in the Pentagon, surely should have examined it from the first to the last paragraph as a part of their work on the new recommendations, admitted they had never heard of it! It was promptly produced, however, by a scholarly Ordnance Department official who has been on this work so long that he has learned never to forget anything, agreeable or disagreeable.

The Hoelscher Committee undertook its prolonged and faithful study with one consideration paramount; namely, the one so well stated many times by professional logisticians, whether military or career civilians—that effectiveness and dollar economy are both desirable but, of the two, only effectiveness is absolutely indispensable.

MOST significantly, each study group is made up of experts in various fields, but in every one of them the dominant percentage is of veteran military logistics operators (whether military or civilian) and of veteran combat officers, with the latter group holding several chairmanships. Serving the field soldier remains the objective. All else is incidental. If the whole Hoelscher study is placed in that key, there will be rejoicing.

The Fallacy of Neutralism

In past centuries neutrality often was a legitimate posture for a nation to assume, but in the present contest of ideologies it is more often a cloak for an expensive form of political blackmail

Maj. Reginald Hargreaves

TO the end of his days, Napoleon complained that the campaign in the Iberian Peninsula had been the "running ulcer" that had drained away his strength. In these days the "running ulcer" that is steadily vitiating the non-Communist Western nations is neutralism.

Throughout the dynastic wars of the seventeenth and eighteenth centuries, neutrality was a perfectly legitimate posture for a nation to assume in the ever-shifting alignment imposed on the European kingdoms by the balance-of-power concept to which they all adhered. Neutralism was possible, of course, only in a state strong enough to scorn threats and clear-sighted enough to resist cajolery. The decision to adopt and abide by it argued a potency and international standing not to be challenged lightly.

In many instances the state that was mighty enough, or sufficiently isolated geographically, to stand aside in any quarrel between the major powers could profit very handsomely out of the war-begotten needs of the belligerents, for they would be in the market for naval and military matériel. Provided that neither of them was in a position effectively to enforce the laws against contraband of war, large sums could be earned from either side.

In Britain's three wars against the Dutch to win predominance in the lucrative spice trade and the equally profitable carrying trade, the Scandinavian countries furnished both sides with essential marine stores—Stockholm tar, cordage, and the like—while the British Navy Board's contract for masts and lumber helped materially to put the New England timber industry on its feet.

Major Hargreaves, a retired officer of the British Army, is a well-known historical writer and a frequent contributor to ORDNANCE magazine.

Conversely, neutralism, if honestly observed or drastically enforced, could penalize the nonparticipant as grievously as the restrictions on trade suffered by the belligerents themselves. Napoleon's Berlin decrees of 1806 and the retaliatory British Orders in Council of the year following, played havoc with the commercial prosperity of the Baltic States and Scandinavia.

FROM 1862 onward, the bankrupt cotton-spinners and ragged hunger-marchers of Lancashire were part of the price that Britain paid for her neutrality in the War between the States. Holland's plight in World War I was directly attributable to the stand she adopted as a neutral. Nonbelligerency has its sacrifices no less than war.

In some instances, however, neutrality was found to be a highly marketable commodity. In the third of those selfsame Anglo-Dutch wars, Britain concluded an alliance with the French, not so much on the score of their worth as coadjutors but because, in the words of that long-headed monarch Charles II, "if *we* don't have them the Dutch will." In effect, the French Navy had a certain nuisance value that both sides were concerned to deny to the opponent, while the Gallic treasury was a fount of wealth that the States General and the English king were equally keen to tap.

SWITZERLAND, the perennial neutral, has owed her long immunity from conflict as much to her usefulness as a clearing house for international finance and the belligerents' intelligence networks as to her geographical position and the unsuitability of so much of her terrain for warfare's prosecution.

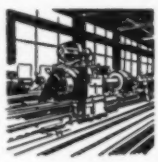
Under the earlier dispensation, therefore, neutralism was not only both feasible and legitimate, but could be the source of substantial, if hazardous, gain. But since 1945 the whole rationale of the world has changed. Riven by two antagonistic, irreconcilable ideologies, ever hovering on the brink of open warfare, it has passed the stage where neutralism can assert its erstwhile right to stand aside.

Neutralism can only rank as such as long as it is respected by those actually engaged in the struggle and strong enough in itself to ensure that it is left alone in its self-decreed aloofness. To how many of the "uncom-

mitted" communities can that be said to apply today?

IT is notable that nowhere is there to be found more perfervid protestations of neutralism than among the peoples who recently have attained to rickety nationhood, or are in the process of achieving it. To pretend that any of them are possessed of potential value as active allies is seriously to overrate them. Yet in many instances the territory they occupy is of the greatest strategic importance, while their nuisance value in the enemy camp might prove considerable.

The salient factor to be taken into account is that, from the outset, the postwar campaigns for "nationalism" have been assiduously exploited by the Communists for their own ends. As even that world champion amongst temporizers, Pandit Nehru, was fain to confess: "It has become very patent in the last year or so that, in the East, Communism succeeds only when it is allied to nationalism"—from which, be it noted, it aims eventually to take over.



As a preliminary move in their design to bring them to subjection, the Reds are extremely adroit in encouraging effervescent, upstart communities to try and run before they have even learned to walk. The result is that they speedily wear out their sandals, and, lacking the means to buy another pair, immediately look around for someone to subsidize them.

In the first instance they invariably turn to the power whose guidance they have only recently repudiated; and nine times out of ten the necessary financial support is forthcoming.

But "appetite comes with eating," and the demands increase as readiness to comply with them is found to expand. If the original benefactors are at some point constrained to cry a halt, then recourse is promptly made to the United Nations Organization, the World Bank, or the generous Foreign Aid funds of the United States—accompanied by a broad hint that if the requested assistance should not eventuate there are "other sources" that would doubtless prove more amenable.

Since everyone is perfectly well aware that the "other sources" referred to are to be found in Moscow or Peking, the petitioner's pleas are hastily complied with—"without any strings"—lest his extremely fluid adhesion be transferred instantly to the enemy camp.

The unenticing spectacle of a suppliant with a begging bowl extended in one hand while the other clasps a dagger, partially concealed behind the back, is one to which the present-day Western world has grown only too accustomed. Indeed, this species of political blackmail has been in operation for some considerable time, and what it has cost the free nations of the West —in particular the United States—is almost beyond calculation. And all they have received for it is a continuing state of uncertainty.

Now it is generally agreed that "cupboard love" is scarcely worth the purchasing, since it is based upon nothing more substantial than a lively expectation of favors still to come. Equally, all this prattle about being "uncommitted" deliberately shies away from the fact that the folks whose plea it is are committed to a steady process of erosion and subornation by the evil influences which their invertebrate "neutralism" prevents them from expelling from their midst.

IT follows that in these days neutralism cannot be anything but suspect, since it leaves subversion entirely free to carry on its campaign to destroy all that the West is committed to preserve.

Surely it would be not too much to ask these voracious gobblers of bounty openly to declare on which side of the fence they propose to take their stand. In these days of complete ideological rift, the erstwhile practice of running with the hare while hunting with the hounds is no longer practical politics. He who is not with us is against us; better a known enemy than a false friend.

"Since 1945 the whole rationale of the world has changed. Riven by two antagonistic, irreconcilable ideologies, ever hovering on the brink of open warfare, it has passed the stage where neutralism can assert its erstwhile right to stand aside."

The timidity which refuses to submit to so simple and elementary a test inevitably fosters the suspicion that a more lavish promise of aid from the enemy camp—accompanied by a broad hint as to the dire consequences that well might follow on its nonacceptance —would bring about a *volte face* as comprehensive as it was forgetful of past favors.

IN these new communities, more concerned with handouts than with the cultivation of a sense of political reality, "aid without strings" is no more than a euphemism for casting bread on the waters to be bolted by a mouth that is just as likely as not to bite the hand that feeds it. Loyalty, we know, is not a commodity that can be purchased. None the less, it would not be too much to demand a firm declaration of political faith before plunging the hand too deeply in the pocket.

Yet any such suggestion is instantly met by a yapping chorus of protest—as loud in the West as in the East—to which the milch-cow nations are apt to pay far too much attention. Issues should be faced up to squarely and courageously if "out of this nettle, danger" we are to "pluck this flower, safety."

The recent handling of the situation in Laos furnishes a perfect case in point. Here we had a land whose very existence depended upon the bounty dispensed by the West—in the main, by the United States. An administration, alleged to be in sympathy with the non-Communist powers, was confronted with a Red insurrection known to be inspired from neighboring North Vietnam and heavily subsidized by the Kremlin. To put down what was nothing less than an attempt forcefully to impose Communism on a country in which at least a moiety of the population rejects it, was—and remains—a task quite obviously beyond the resources of the reigning monarch and his principal adviser, Boun Oum.

Yet America's thoroughly commend-

able suggestion to support the legitimate Government with direct military aid was instantly greeted with a whinnying jeremiad of remonstrance, and the fatuous suggestion to refer the whole question to a 3-power "watchdog" commission.

But such a commission—appointed to "supervise the country's neutrality" —was already in existence, in a legalistic sense, although completely ignored. To seek to reconstitute it would be to try and breathe life into a corpse; for what likelihood would there be that the Reds would be more ready to recognize its authority in the present than they have in the past? Could temporizing timidity go further?

WHAT is wanted is a clear-cut, unequivocal affirmation on the part of the Laotian Government—and the same goes for all those of similar kidney —that it adheres wholeheartedly to the West. With that, its right to call for military aid would be undisputed; and the very fact that it was known that such aid would be forthcoming would very probably obviate its deployment. As Marshal Lyautey always used to insist: "A display of strength will often do away with the necessity for using it."

The outcome of timorousness and vacillation has already been starkly demonstrated in the unhappy case of Indo-China. There Admiral Radford's forthright plan of action was whittled away and watered down and finally swept into limbo by a member of the British Cabinet—a "good" man in the very worst sense of the term; for as Henry Adams took occasion to remind us, "It is always the good men who do most harm in the world."

As a result, North Vietnam became an open base for Communist expansionism, while in South Vietnam the cardinal virtues of democracy have degenerated into their complementary vices: liberty has become license; opposition, anarchy; free discussion, armed conflict; the limitations on firm government, administrative impotence—and the mass of the people, with no specific political affiliations, go in fear for their lives.

"The Reds are extremely adroit in encouraging effervescent, upstart communities to try and run before they have even learned to walk. The result is that they speedily wear out their sandals, and, lacking the means to buy another pair, immediately look around for someone to subsidize them."

Of no less vital importance is the fact that the whole of the United States Pacific Ocean strategy is imperiled by these Red-infected "neutrals" on the seaway's western flank.

In a global showdown between the Western Powers and the Communists, everybody would have to take sides. Every nation, however small, would be either sucked in or trodden in. It is perfectly legitimate, therefore, for the West to turn to the "uncommitted nations" and demand to know *now* on which side of the fence they propose to come down. On so plain and straightforward an issue, to palter and procrastinate and postpone is in itself a kind of surrender.

As Georges Clemenceau so sagely pointed out: "Every man or every power whose actions consist mainly of surrender can only finish by self-annihilation. Everything that lives resists; that which does not resist allows itself to be cut up piecemeal."

Mammering indecision and wincing refusal to put the sort of question that demands an unequivocal answer, approximates very closely to appeasement. And appeasement simply multiplies the dangers it seeks to evade.

If the Communists decided to embark on global war *à outrance*, nothing on God's good earth would be able to dissuade them. At the moment "peace" is the form of warfare they have chosen to exploit. So far, a full-scale resort to arms has not been necessary; they have done quite well enough by intrigue and subornation and by getting others to burn their fingers pulling the chestnuts out of the fire for them.

SINCE 1945, without firing a shot in anger, Soviet Russia has added 700,000,000 people to the multitude that was already under her rule and expanded her empire by over 5,000,000 square miles; while at trifling cost Red China has expelled Chiang Kai-shek's Nationalists from their native soil and acquired hegemony over Tibet, Indo-China, and North Korea.

In the fifteen years since the end of World War II only in three instances, where the Red challenge was met with promptitude and courage, have Communist designs been halted.

Such facts embody a clear and unmistakable warning to any nation which is not prepared to declare its adhesion to the West in terms that allow of no possible misapprehension—a West that should render it plain past any peradventure that, if called for, wholehearted help would be forthcoming instantly for anyone who openly abandoned "neutralism" for the non-Communist side of the fence.

IT is a waste of time for the Western powers to keep on telling the Communist bloc about their military strength and resources. They know all about that already. What they ought to be told about, and shown, is the depth and cast-iron quality of the Western powers' determination.

The "Summits," which invariably turn out to be crevasses indifferently papered over; the round-table conferences, where Western standards of political integrity always offer openings for the Communists to outsmart them —all this lumber of a moribund diplomacy is as meaningless as the shibboleth of 'peaceful coexistence' which is simply a means of Communizing the world without resort to war.

We live in an age of naked challenge, and the worth of the values we champion should be reflected in the celerity and courage with which we pick up the gage. In this era of clear-cut issues and categorical affirmatives there is no place for the temporizer, the straw-splitter, the star-gazer with his eyes so firmly fixed on the firmament that he fails to observe the angry torrent swirling all about him. Above all, there is no place for those "Damned neuters with their middle way of steering, neither fish, flesh, fowl, nor good red herring."

Reliability—Not Gadgets

Much of our armament is becoming too sophisticated for ease of operation and maintenance, so we must forsake searching for the perfect weapon and seek the simple, effective, and inexpensive

Maj. Gen. Dwight E. Beach

IT has been said on good authority that ninety per cent of all men who have ever been trained in science and technology are living today. To phrase it another way, ninety per cent of man's knowledge of science and technology has been acquired in the last 100 years—two per cent of recorded time.

Today we live in an era when things we used to believe were impossible, or were decades away from reality, are now coming to reality or are just beyond our fingertips. Travel in space thirty years ago was a dream. Now it is within our grasp. This phenomenon has come about only since the end of the Second World War.

Dr. Vannevar Bush has stated that the five years of World War II used up thirty years of basic research. From this heavy drain came the need for new and more scientific information. The Army alone now spends approximately $30 million on basic research—the *sine qua non* of applied research—from which the equipment comes that our Army requires.

THE officers who are being graduated today will be going out to new assignments, and some will immediately find themselves involved in research and development projects. Sooner or later all will become associated with R&D in some capacity—the Ordnance Corps alone utilizes sixty per cent of the entire Army research, development, test, and engineering budget. Since I have just recently come from commanding the 82nd Airborne Division—one of our combat-cocked STRAC Divisions, I can speak with authority on the absolute necessity today for good Ordnance support for combat troops. Weapons and allied equipment are the combat soldier's tools in trade. Individual lives —even national existence—can depend on them. They must be good, but they must be simple and rugged, with ease of maintenance and rapidity of repair. And in this era of worldwide U.S. strategic commitments, where rapid air deployment to any part of the globe is possible, we must have lightness of weight.

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The M3 submachine gun of World War II is an excellent example of a simple yet dependable and inexpensive firearm.

Today we are engaged in a deadly struggle with Communism for national survival. The challenge of Communism, as comprehensive as it is critical, spans the economic, social, and political areas of action as well as the military phases.

Don't let current attempts to downgrade the tremendous importance of this ideological struggle deceive you —the choice is between freedom and slavery. The game is winner-take-all, and no prize is awarded for coming in second.

To win, the U. S. must stay strong—economically, militarily, and morally. To stay strong militarily, we must depend as never before upon the imagination and boldness with which we acquire and utilize new scientific discoveries and industrial techniques for our national defense.

WE have chosen not to compete with the Communists on a weapon-for-weapon basis. Rather, we aim at achieving and maintaining a clear qualitative superiority while keeping within the bounds of economy and time.

There was a time when our Army could develop and produce a weapon or a piece of equipment and use it until the day it wore out. That day is gone.

The Honest John field-artillery rocket is a simple and uncomplicated system.

While the horse and lance remained a major weapon system for 2,000 years, it is doubtful if the tank and manned combat airplane—as we know them today—will last a hundred. We are making an effort right now to forecast and develop the equipment our forces will need in the period 1970-1980, and much of it will be radically different from anything any of us has ever used.

ONE of today's big research and development problems is how to produce the end product in the face of ever-zooming costs and unending obsolescence. If we are going to save this Nation and the world in the gigantic struggle of our time—freedom against slavery, order against chaos—then we are going to have to conserve both time and money.

Part of the answer rests with ensuring that our future equipment be covered by what I will call the "SERC concept"—standing for "simple, effective, reliable, and cheap." We are in the Volkswagen not the Rolls-Royce class. We want a good design, initially. We want function, not frills.

We recognize that there are certain factors which are in normal opposition to each other that must be reconciled or reversed if this concept is to be made to work. As a general rule, a cheap item is not always a reliable one; similarly, simplicity does not always meet the requirements of effectiveness, nor does light weight necessarily allow retention of reliability. But these opposites can and must be made to operate in harmony.

Since World War II there has been an increasing tendency to develop equipment along more complex and sophisticated lines. This has led to increased cost, decreased reliability, and difficult maintenance problems for the using troops. The more complex the system, the more difficult it is for human action to adapt the device to the military environment. Some weapon planners persist in developing systems of fantastic complexity. The result can be an amazingly sophisticated device of truly marvelous ingenuity, but of terrific cost and little practical value on the battlefield. This is a trend which must be resisted at all costs.

But it is not a trend which is peculiar to the military service. It is a national disease. Look at the case of the American compact car. The American automobile companies have found that their so-called economy cars sell best when they are coated with luxuries.

One company reports that sixty-seven per cent of the buyers of its compact are paying an additional $80 for the inclusion of such items as bright trim around the windows, white steering wheel, and pleated upholstery. This trend may be within the bounds of the individual buyer's ability to pay, but for the Army we not only do not want it but the Nation cannot afford it.

PERHAPS one of the most outstanding examples of what we in the military are after can be found in the M3 submachine gun of World War II. This was one of the simplest yet most dependable firearms this Nation ever developed. It cost only some $30, was mass-produced from noncritical materials. It replaced a far more sophisticated submachine gun which cost over $200. But the M3 did the job for which it was designed.

Today we are making progress in this direction. A good example of reten-

tion of simplicity and resistance to all efforts to sophisticate it is the "GOER." The Army requires a cargo vehicle which is capable of real cross-country movement under the most difficult terrain and field conditions. Rather than go into a costly and time-consuming development program, we took a basic vehicle from the construction industry, authorized only the use of commercial components, resolutely resisted several attempts to sophisticate it, and came up with a usable product in a very short time.

ANOTHER excellent example of this is the M55 chemical rocket and the companion M91 launcher. Designed as an area weapon, we have successfully resisted all attempts to add nice-to-have refinements. This weapon is rugged, reliable, inexpensive, simple to operate, and *it does the job.*

In the missile field, the Army's record is, with a few exceptions, equally good. Jupiter, for example, was ready for field use three years after research and development began. We did this by sticking hard and fast to the original concept agreed upon by all interested agencies. Numerous nice-to-have features were proposed, but, because of the urgency, these were denied—even though funds to support such finite improvements could have been obtained.

Honest John was eleven years in research and development. Here is an example where we have incorporated some "chrome"—which does not appreciably improve the system's capability. In Honest John we have a simple, reliable system, and the Office of the Chief of Research and Development has steadily tried to fight off attempts to complicate it.

Our new Pershing is progressing on schedule, largely due to the fact that efforts to add marginal refinements have been thwarted. We shall continue to try and keep it on schedule and to deliver a first-class weapon to the Army —one which it can afford, can operate and maintain, and which will do the job.

Another aspect of the problem is man-machine compatibility. This whole question must be weighed at the beginning of a project—in the concept and design feasibility studies—and continued throughout development. In our modern Army, human engineering considerations are taken into account from the very beginning of the concept-design-development cycle.

Moreover, these man-machine compatibility considerations are brought to bear on the problems of maintenance as well as operation. We direct this effort not only at the skills and aptitudes of the troops who will operate and maintain the matériel but also at the environment in which it will be used. Early integration of human engineering and man-machine compatibility can be essential parts of simplicity and reliability.

A weapon or weapon system or item of equipment designed for large-scale issue is absolutely worthless if it takes an army of geniuses to operate it! We must develop our matériel so that it may be operated and maintained by a normal cross section of available manpower. The newest and most advanced weapon of war is no better than the man controlling it.

The Pershing missile is progressing on schedule due to the fact that marginal refinements have been held to a minimum.

Still another aspect of this over-all problem is to keep our effort directed into areas which will give us more than just a marginal improvement. The Office of the Chief of Research and Development has been insisting on periodic reviews of all research and development work projects and the quick elimination of marginal items.

This should not be construed as being aimed at retarding such productive efforts as improvisation and product improvement by soldiers in the field. This will always be a valuable asset in the United States Army. The kind of mind which developed the hedgerow cutter and the vehicle-mounted wire cutter should never be smothered.

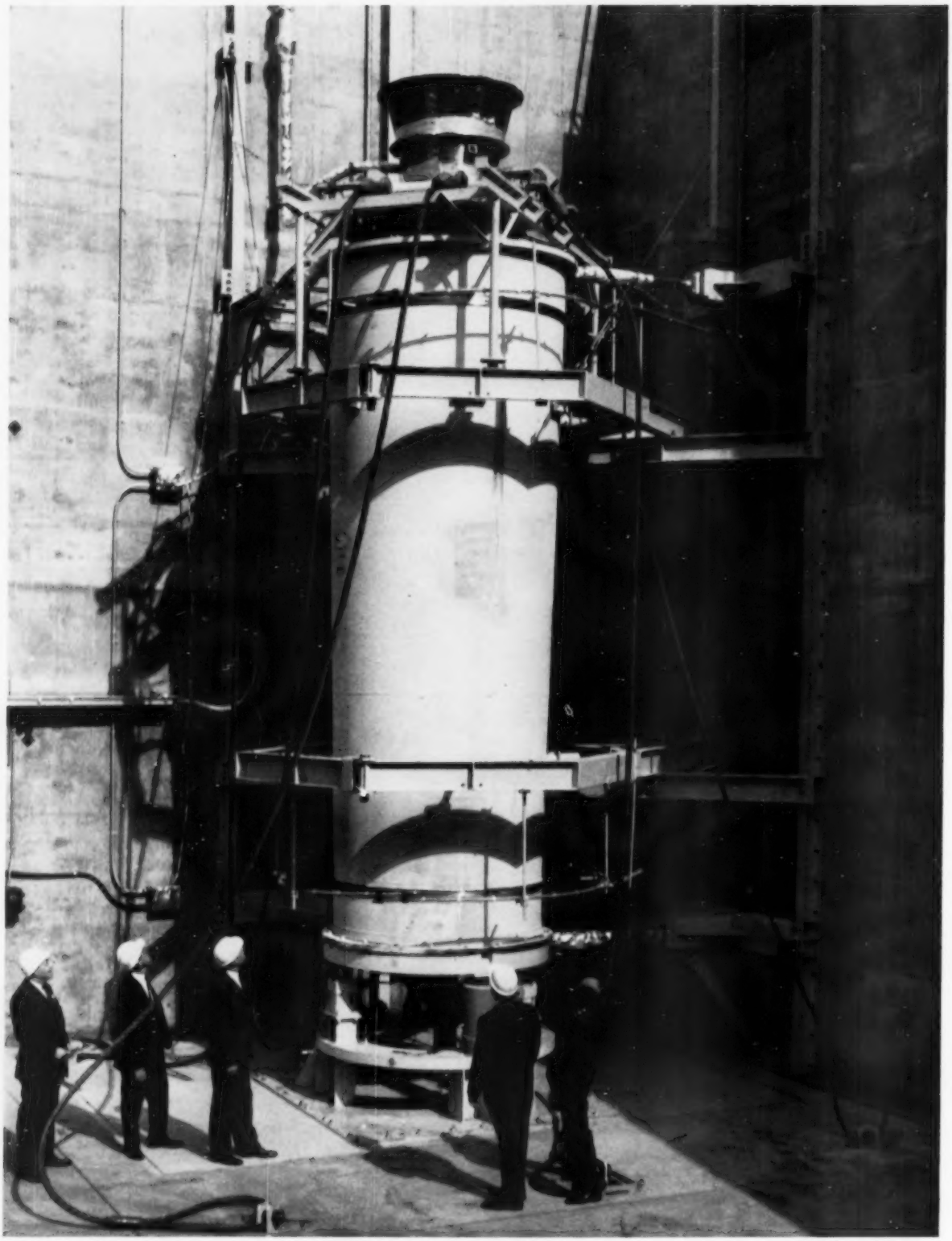
Our goal is simply the most effective utilization of resources and assurance that our total research and development effort is directed toward early fulfillment of the Army's important matériel requirements.

The Russians have a proverb which governs their efforts and should be equally applicable to us—"The better is ever the enemy of the good." It is General Trudeau's philosophy that we should freeze a "good" design early and get the weapon built.

WE recognize that, right or wrong, the American has a tradition and reputation of trying to build one hundred per cent perfection into every tool and machine—yes, including the proverbial kitchen stove. This same tradition naturally keeps appearing in our military research and development. We cannot afford it, and it must be resisted at every instance.

There was a cliché during World War II pertaining to nonessential travel: "Is this trip necessary?" Change that saying slightly and ask yourselves every time a gadget or gimmick is proposed for a research and development item, "Is this gadget really necessary?" Will it help that key individual, the combat soldier, who must, when all our sophisticated weapons have been fired, slog across the battlefield?

New Space Engine



The Nation's first operational prototype of a booster-size segmented solid-propellant rocket motor is inspected by United Technology Corporation scientists prior to its successful static test by the NASA. Fired nose down, the rocket operated for 80 seconds and generated approximately 250,000 pounds of thrust after its 3 segments were joined on the firing site.

Survival in Nuclear War

While an enemy atomic attack on this country could threaten the safety of every civilian, a few simple preparations for shelter or evacuation would greatly decrease the number of casualties

Kendall D. Moll

A PECULIAR chasm lies between two of the most common current American attitudes about modern warfare. On the one side, our citizens dig deep to support military programs costing ten per cent of our national product. At the same time we are so thoroughly intimidated by the Damoclean threat of atomic radiation that we worry about the fallout in our milk supply. Between these attitudes lies a related question which we almost ignore—our chances of surviving an atomic air attack on the United States.

Many people immediately write off their chances for survival in an atomic attack. Others feel that survival is not worth while if it is to be the "stark, elemental, brutal, filthy, and miserable" life predicted by some congressional witnesses. However, realistic and reasonable evidence does not support such a discouraging outlook.

Predictions of long-lasting, life-killing radioactivity have been exaggerated monstrously in the past. The truth is that a great deal can be done to protect people from its penetrating rays. Neither is blast an inexorable hazard; there are reasons to believe that even the cities of New York and Washington—seemingly key targets—might, for strategic reasons, be spared in an attack.

Close examination also indicates much more than bare animal existence for survivors. Even in the heaviest attacks, a great amount of material goods would remain to sustain life. Rapid recovery of the economy could occur, as in Germany and Japan, if social structure and individual incentive were maintained.

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But our efforts to assure survival and recovery will require personal initiative, study, work, and money. We must have a Noahlike faith or a rational belief in order to make such self-sacrificing efforts. Since most of us prefer to devote our faith to the chances of peace, it is clear that civil defense must be based on rational belief.

This belief need not be based on fear of certain attack—even a small chance of attack is sufficient cause for prudent preparations—but it must include a recognition of the value of civil defense. And to make a convincing case for civil defense, a series of questions should be answered: (1) How many and what kinds of weapons might be used? (2) What are the probable targets? (3) What are the hazardous areas of blast, radioactive fallout, and fire? (4) What can we personally expect to gain by preparing against these hazards?

It is hopeless to attempt to give definitive answers to these questions, but a reasonable basis for action at least can be provided by a conscientious assessment of nuclear realities.

The threat of surprise attack to this country is not determined primarily by the number of Russian nuclear weapons but rather by the much smaller number of their intercontinental delivery vehicles.

A consensus of several recent public statements is that the Russians currently have perhaps 350 medium bombers, 150 heavy bombers, less than a hundred intercontinental missiles (ICBM's), and not more than a few missile-carrying submarines. Most of the medium bombers are prohibited by their limited range from round-trip attack on the continental United States. Thus the number of delivery vehicles available for attack on the United States is probably not more than 300.

MANY factors would act to decrease the number actually used. A large fraction might be held in reserve, and many of those sent off would never arrive on target. The most frequent publicly quoted estimates of interceptor "kill" percentages for bombers are from ten to forty per cent. No effective ballistic missile defense exists yet, but about fifty per cent of the launched missiles might fail to reach the target area on account of their inherent unreliability.

By combining these estimates, we can obtain a very rough over-all estimate that the potential first-strike nuclear threat to this country amounts to perhaps 200 delivery vehicles.

The sneaking of bombs into the country in merchant ships, nonmilitary aircraft, suitcases, and the like would doubtless be too risky except possibly for a few of the most essential targets. Aircraft delivery of bacteriological or chemical weapons, and sabotage or surreptitious poisoning of food or water would be even riskier, since the timing and extent of the effects would be less certain. While officials are not ignoring the possibilities of attack with these "scare" weapons, they cannot afford to divert much of the limited civil-defense effort away from the preeminent nuclear threat.

THE vital targets which would be subjected to the earliest and most certain attack are those military bases which could rapidly launch a retaliatory attack. These targets would consist of Strategic Air Command bomber bases, intercontinental missile launch sites, and naval bases for aircraft carriers and missile-carrying submarines. The current list of such targets is rather small—probably not many more than fifty within the United States. Most of the other 800 military installations in this country (with the possible exception of key air defense centers) cannot be considered first-priority targets.

An enemy would not feel quite the need for a sudden surprise attack on other military targets, so these targets would have a better chance for warning. About 200 targets in in the United States could probably be considered of secondary military importance.

These targets would include defensive installations, alternative or support airfields for bomber forces, large Army and Navy bases, arms depots, and primary support facilities. In addition, many large municipal airports and those used for military reserve squadrons might be targets.

However, most supply depots, production and repair facilities, and administrative centers would not, in themselves, be logical early targets because they could not contribute to an immediate military countermove.

The attacker's strategic viewpoint would have a strong influence on the choice of targets. The Allies placed dozens of types of targets—ranging from barges to ball-bearing plants—in a high priority at various times during World War II.

Although the Russians (who did very little strategic bombing in World War II) might have equally uncertain priorities, studies of their writings indicate that they continually emphasize military objectives and that they have in the past strongly denounced the Douhet theory of "saturation" attacks on the civilian population.

We would be shortsighted to assume an attack on most of our major cities merely because it reflects our own worst fears.

Of course, the possibility of attack aimed at our population and industry must be acknowledged. The 157 largest urban centers in the United States contain about half of our population and 70 per cent of our industry in less than one-half of one per cent of our land area.

But the destructiveness of an attack on population targets raises a question of its value to the enemy. The enemy strategists could desire, instead, to concentrate on tactical objectives by hitting our military forces and closely related civilian support facilities. In this way they could pursue their more immediate and pressing objectives while retaining the threat of future attacks on cities as a blackmail menace to our government and people.

Historical evidence of the results from conventional bombing of specialized industrial targets indicates that it can, under some conditions, be highly effective. We might have found it much easier to project this experience to possible future strategies if the explosive potentialities of air weapons had not increased so vastly since 1945.

But it now appears that the single targets of World War II may not be worth aiming at with nuclear weapons. To knock out an oil refinery or a railroad yard with an H-bomb would be like bombing a sniper with a World War II blockbuster—both violate the military precept of economy of force.

It therefore appears that only the largest and most obvious specialized targets would be worth hitting in a nuclear attack unless they are coincident with other profitable target systems. Such targets might include the half dozen or so major atomic-energy facilities, a half dozen critical waterways and port facilities (about 90 per cent of our foreign commerce passes through the 20 largest ports, and most of these are in metropolitan target areas), a couple of dozen refinery centers (most production from the 300 U.S. oil refineries is grouped in only a few areas), and a dozen or so miscellaneous targets such as some of the larger dams and power sources, communications stations, and chemical complexes. These add up to perhaps fifty special targets.

THE possible targets which have been presented above include almost all the types which an attacker could be expected to select; a certain number among them would have to be chosen according to his delivery capability and strategic objectives. A reasonable estimate of the number of various types of targets might be as follows:

Highest priority military bases	50
Second priority military bases	200
Population centers	157
Specialized industrial targets	50
Total	457

This total is more than twice as great as the estimate of first-strike vehicles. Thus, even in a sudden all-out attack, the people in most of the likely target areas would not be hit.

An area of several miles in each direction around a hydrogen bomb explo-

"Many people immediately write off their chances for survival in an atomic attack. Others feel that survival is not worth while if it is to be the 'stark, elemental, brutal, filthy, and miserable' life predicted by some congressional witnesses. However, realistic and reasonable evidence does not support such a discouraging outlook."

sion would be destroyed. In the case of a modest one-megaton weapon, the range of essentially complete housing destruction would be about four miles; in the case of a bomb the size of the 1954 Marshall Islands test, the range of destruction would be about ten miles.

When the commonly assumed five-mile aiming uncertainty is added to these distances, it is evident that all locations within ten to fifteen miles of a target are in a serious blast danger area. In a large, widely dispersed city which could serve as a target for several bombs, this danger area can extend out to twenty-five miles or more from the downtown area.

An additional hazard is fire—

Taking shelter from blast and fallout or evacuating the target area is vital to survival from atomic attack (Army photo).

the burned-out area under some conditions could extend twenty miles or even farther from the burst point.

A small number of weapons probably would be detonated at random locations outside the target areas, but the chances of such a hit damaging any particular location would be very low (the 4-mile destruction ring of a megaton bomb would cover only 1/60,000th of the area of the United States). The primary danger outside the target areas undoubtedly would be from fallout.

THE distances and total areas threatened by fallout are about ten times the range and area of blast effects, but fortunately fallout is easier than blast effects to defend oneself against. A good fallout shelter such as an enclosed basement stocked with food and water could protect people from lethal dangers in almost all fallout areas outside the blast zone.

If a basement shelter were strengthened by building a homemade wooden lean-to for protection against collapse of the upper stories, it could save up to half of the blast casualties as well.

But even if we neglect the potential blast protection of fallout shelters, we can rest assured that the few dozens of dollars per family necessary to provide a fallout plan are well worth the cost. In cold statistical terms, the improvement in one's chances of survival around a single one-megaton burst are approximately fifty per cent better.

In the conditions assumed, modest fallout protection is as effective a measure as moving twenty-five miles farther away from the burst. Under nuclear attack, twenty-five miles or its equivalent can mean a great deal, and since no one can say for certain where a bomb might drop, a fallout shelter is generally more reliable as well as more convenient than evacuation. However, evacuation also can prove very valuable when warning is available.

Obviously, a capability and willingness either to take fallout shelter or to evacuate from target areas could prove to be the difference between life and death, particularly if families were prepared to exist on their own resources, cut off from outside facilities.

Four questions regarding the outlook for atomic attack have been raised in this article and subsequently answered. Let us now bring the answers into a meaningful pattern.

1. Perhaps 200 nuclear weapons currently could be delivered in a surprise attack on the United States.

2. The most likely nuclear targets in the United States are the fifty or more air and missile bases from which retaliation could be made. Since about 200 other military bases, 150 urban targets, and 50 isolated industrial facilities could be secondary targets, few people would be very distant from a potential target of some sort regardless of their geographical location.

3. Hazardous blast and fire areas exist within ten to twenty-five miles of targets. Fallout areas extend hundreds of miles downwind, most frequently in an easterly direction from the burst point.

4. The most appropriate civil-defense actions are different for cities, suburbs, and rural areas. Fallout shelter is of potential value in all areas, but if sufficient warning is available evacuation can be of even greater value to residents of target areas. Such measures could increase the number of atomic attack survivors by ten per cent or more—if they are planned for in advance.

Civil Defense Is Vital

Past indifference to this important phase of our national security is finally being dissipated and, with the Department of Defense in charge, workable plans now will be made for shelters and evacuation

THE United States is aroused at last. It has lacked armed forces adequately equipped and manned to win peripheral wars, limited wars, or "brush-fire" engagements. It has lacked any effective defense of its civil population. At last a President of the United States has decreed:

"More than ever a strong civil-defense program is vital to the Nation's security. Today civil defense is of direct concern to every citizen and at every level of Government." He is aware that we are faced with the grimmest test of our strength since World War II.

Past half-hearted indifferent interest in civil defense is exemplified in the appropriations allotted—a paltry $619 million over 10 years by Congresses that made cuts averaging 74 per cent of administrative recommendations.

The Office of Civil Defense and Mobilization has made a resolute effort to promote interest in the problem. It prepared a mass of over 200 publications: the National Plan with forty-two annexes, regulations, advisory bulletins, technical bulletins, and guides for civil-defense personnel. (Few read them.)

It organized and encouraged State, county, and city civil-defense organizations. (Voices in the wilderness.) It implored industry to make survival plans. (With a few noteworthy exceptions, the indifference has been colossal.)

In cooperation with the North American Air Defense Command, the OCDM established the Conelrad radio warning net and set up air-raid siren systems in all large cities. But how many people have battery radios and how many know the signals or have a plan of action if the sirens wail in earnest?

Although some efforts have been made in past years to interest the American people in the need for fallout shelters and evacuation plans, little practical work was done in this field.

However, with the approach of the Berlin crisis, President Kennedy called for increased emphasis on a civil-defense program and delegated the principal authority for its implementation to the Department of Defense.

In the accompanying study, the editors of ORDNANCE *review the background and highlights of the situation.*

The indifference has percolated from the top rung of national leadership that has apparently believed: "It couldn't really happen; we must not alarm our citizens or the Communists; and besides think of the cost." The panacea was to evacuate the cities. (Imagine the city-bred hordes, thirsty and hungry, swarming over the farmlands and villages!)

THE need for civil defense is based on varying estimates, the generally accepted one being that 25 per cent of the population would die or be hopelessly sickened if 150 key areas and cities were struck in a nuclear attack and there were no shelters. It is estimated that the provision of fallout shelters would reduce the loss to five per cent.

A loss of one fourth of the population certainly would cause a complete breakdown of our economic and political machinery, and the Nation might never recover from the chaos. With fewer casualties we could survive. Therefore, it becomes a citizen's duty to seek means to aid his own survival.

Blast shelters also have been studied, but their expense would be astronomical, and, except on the fringes of ground-zero, even the sturdiest might not survive.

ON the strong probability that many bombs and missiles would go astray in any attack, the present concept of fallout shelters in public buildings, even in key cities, makes great sense. It also makes it equally important for the home owner one hundred miles or more from a probable target point to have a shelter with some blast resistance as he could be on the edge of a "near" miss.

A recent conference of State governors urged a 5-point program: (1) provide fallout shelters in all appropriate buildings, (2) provide income and real-estate tax relief for builders of privately constructed shelters; (3) stock food and medicines in strategic locations; (4) construct alternate seats of government; (5) assist in preparation of building specifications for fallout shelters.

The governors also urged continued civilian control of civil defense and that "wherever possible operational functions should be carried out by civilian authority."

Frank B. Ellis, OCDM Director who had fought hard for a stronger civil defense, appeared to agree with the gov-

ernors. However, after conferences with his cabinet, principally Defense Secretary Robert S. McNamara, President Kennedy ordered the delegation of the major operations of the civil-defense program to the Defense Department.

THE Executive Order cannot help but put an additional burden on the military in spite of Secretary McNamara's statement that "the civil-defense effort must remain under civilian direction and control" and that its functions "must not be permitted to downgrade the military capabilities of our armed forces."

This is a shift away from the previous approach and from the manner the problem was handled in World War II, especially in England.

However it makes sense in the event of the wholesale death and destruction that would follow a nuclear attack. With communications and transportation shattered, Reserve, National Guard, and many small Regular service units could not move and would be available locally, and, with the police forces, would be the only trained and disciplined units that could prevent mass hysteria, control desperate mobs, and restore order.

The immediate problem is to ensure that the readiness of our armed forces is not watered down. Although 1,000 personnel of OCDM are being transferred to Secretary McNamara's control, he has mentioned the Army's Corps of Engineers or the Navy's Civil Engineer Corps for conducting the initial survey for fallout shelter space, a step that normally would lead to supervising modifications of buildings.

There is also the matter of guarding and renewing the "survivors' stockpiles" and of additional postattack training of Reserve and Regular forces.

It will require thoughtful planning and considerably more personnel to avoid downgrading "the military capabilities of our armed forces." A warning of mixed-up thinking appeared in editorial comment to the effect that the care of the civilian population in wartime is essentially a military problem. If care of civilians is to become a military instead of a political problem, who is going to fight the war?

Nevertheless the Defense Department "has the ball" and it is evident from our past weak approach that, as the Executive Order stated, "the rapid acceleration of civil-defense activities can be accomplished most effectively and efficiently through performance by the regular departments and agencies of government of those civil-defense functions related to their established roles and capabilities."

On the surface, some devious thinking is required to equate the mission of the Defense Department with surveying public buildings (under the supervision of the General Services Administration) or helping the civilian population to design and construct fallout shelters.

However, shelter is only a part of a problem that requires integration of a warning system, radiation detection, control of hysteria, and restoration of communications and transportation throughout the country as far as possible.

Unless one wishes to establish a disciplined national civil-defense service, there is no single authority better able to coordinate and direct civil defense than the Defense Department—always with an eye on the fact that even if the armed forces are mobilized there will be rear-guard Reserve units available to maintain order.

The specific functions delegated by Executive Order to the Department of Defense are to develop and execute:

1. A fallout shelter program.

2. A chemical, biological, and radiological warfare defense program.

3. All steps necessary to warn or alert Federal military and civilian authorities, State officials, and the civilian population.

4. All functions pertaining to communications, including a warning network, monitoring, instructions to shelters, and communications between authorities.

5. Emergency assistance to State and local governments in a postattack period, including water, debris, fire, health, traffic police, and evacuation capabilities.

6. Protection and emergency operational capability of State and local government agencies in keeping with plans for the continuity of government.

7. Programs for making financial contributions to the States (including personnel and administrative expenses) for civil-defense purposes.

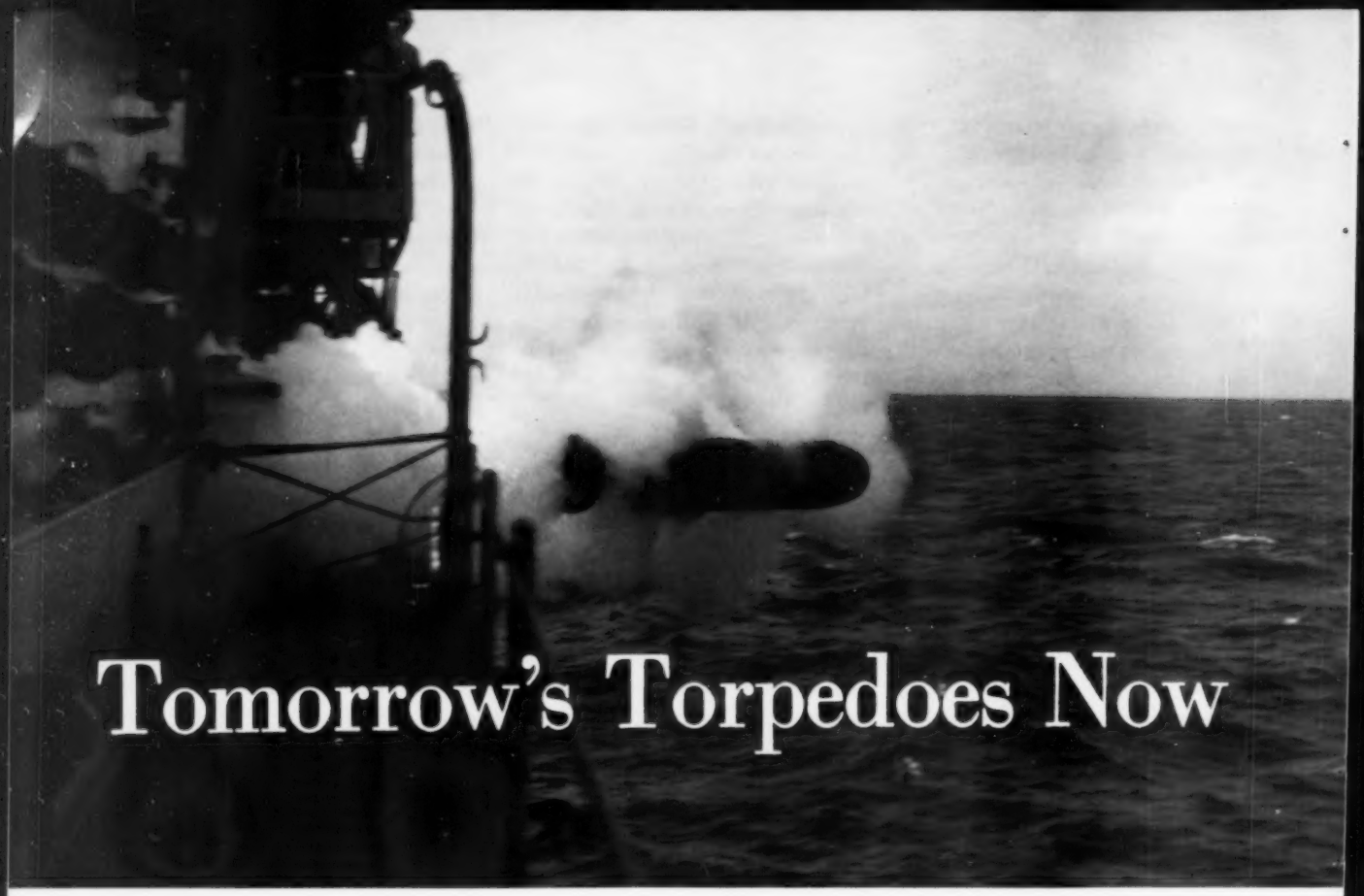
The President has requested the director of OCDM also to develop plans for the continuity of Federal, State, and local government operations in the event of attack.

OCDM will continue to be responsible for economic-warfare matters, the restriction of imports threatening national security, and the maintenance of the strategic and critical materials stockpile.

SECRETARY McNamara, as if he didn't have enough to do with a $47 billion defense budget, carried the battle to Congress, a sympathetic one at last, for the total of $311 million for civil defense. The sum included the $104 million originally requested (chopped down to about $90 million by earlier congressional committee action) and the $207 million supplemental amount requested by the President.

The Secretary explained the proposed first year's expenditures of a program that could finally cost between $20 and $40 billion dollars as follows: $93 million to survey existing space in public and commercial buildings, deadline December 1962; $10 million for a test program of means to increase potential shelters' capacity, mostly by improved forced-draft ventilation; $7.5 million for planning and constructing shelters in new Federal buildings; $9.3 million for detection instruments; $13.5 million for research and development; $5.5 million for communication systems; and $10 million to make the Near home warning buzzer system operable. The remainder was for administration and many miscellaneous expenses.

If United States citizens are not prepared to protect themselves, the country becomes an inviting target for those who wish to eliminate freedom. Without people there can be no nation. Therefore it is the duty of every citizen, even though he may wish to play the fatalist and do nothing, to participate fully in the civil-defense program.



Tomorrow's Torpedoes Now

William O. Foss

THE ever-increasing threat of the Soviet submarine fleet, coupled with the recognized fact that the modern submersible and its fighting techniques are superior to today's antisubmarine warfare methods and equipment, has given impetus to one of the Navy's top priority research programs —to develop the torpedo of tomorrow today!

The research program, known as Retorc (Research Torpedo Configuration), and the inherent problem of how to develop the torpedo of the future, is a serious matter to Navy Ordnance experts.

During past wars the depth charge and mine were the main weapons used to destroy submarines. Today, we still use these weapons—there's the atomic depth charge "Betty"—but since future wars will see submarines fighting submarines, the torpedo looms as the most effective antisubmarine weapon.

While our air missiles have progressed fabulously during the past ten to fifteen years, the underwater guided missiles—the torpedoes—are not much different today than they were during World War II days. And the torpedo designs haven't changed much either—they are about the same as they were when Robert Whitehead first began experimenting with torpedoes back in 1864.

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To meet the advantages held by the modern nuclear-powered submarines, the Navy faces a great technological challenge in developing speedier, quieter-running, longer-range, and deadlier torpedoes. The research programs undertaken under Retorc seek to develop these new weapons.

The Navy's Research Torpedo Configuration Program is actually two programs—Retorc I, which seeks to develop small, lightweight torpedoes weighing less than 500 pounds, and Retorc II for developing larger torpedoes with weights up to 4,000 pounds.

Numerous ideas are explored under both programs. The Naval Ordnance Test Station at Pasadena, Calif., is the focal point for developing superior lightweight torpedoes under Retorc I, while Retorc II projects are divided between the Ordnance Research Laboratory at Pennsylvania State University and the Naval Underwater Ordnance Station at Newport, R. I.

WHAT are the requirements of the torpedo of tomorrow? "Superior performance" is the simple but all-inclusive answer given by Navy ordnance experts and ASW officers.

While superior performance is a simple answer, it is still far from an

achievement in Navy torpedoes. Superior performance in future torpedoes means many things, but foremost on the minds of torpedo experts are these:

Speed.—Future torpedoes will be underwater speed demons compared with today's torpedoes. The higher speed—200 to 300 knots compared with the 32 to perhaps 60 knots of today's torpedoes—is needed not only to overcome the faster-traveling submarines, but the torpedo, if it is an acoustic one, needs the extra speed to make up for the time lost in locating its target in the turbulent water.

Propulsion.—Most torpedoes today are electrically propelled. However, a great technological break-through has been made and the future propulsion system—rocket power—will drive a new acoustic homing torpedo now being developed for the Navy by Aerojet-General Corporation. The new weapon, designated Mark 46, is a lightweight antisubmarine torpedo which not only will have high speed but will be able to reach greater depths than other torpedoes.

Guidance.—Torpedo guidance must be immune to countermeasures and evasive action by the target. The search for accurate and reliable torpedo-guidance systems rates high in the Navy's research and development programs, since new and future submarines and surface ships will be equipped with the most effective countermeasures available to modern military technology.

Today's underwater missiles are either wire-guided or find their target through acoustical listening devices.

Wire-guided torpedoes are not new to history. Electrically powered torpedoes of the 1880's were steered through a cable connected to the launching vessel. In the Navy's first modern wire-guided torpedo, the Mark 39, a specially designed wire connects the torpedo to its launching vessel, and the threadlike wire is played out as the torpedo travels through the water. Over this wire the torpedo receives guidance commands that direct it to its target.

Acoustical torpedoes find their target by listening for the telltale sound of the submarine. Passive acoustic torpedoes listen for sounds made by the submarine, and steer themselves toward those sounds. Active acoustic torpedoes send out pulses of sound, listen for echoes from the target ship, and steer themselves toward the echoes.

Electric brains, or computers, are an important part of the torpedo-guidance systems. The latest innovation, the Mark 112 torpedo fire control system, a computer built by the Sperry Gyroscope Company, is being installed on the Navy's nuclear-powered attack, hunter-killer, and missile-launching submarines.

Using one or a combination of several sensing devices, such as radar or sonar, the system can determine an enemy ship's position, direction, and speed. The advanced geometric problems involved in calculating the best means of aiming the torpedo to hit the target are then solved by the system. All the operator has to do is push the appropriate button, and the electronic brain works out the solution.

A means of activating torpedoes with acoustic guidance systems is included in the fire-control system. When the torpedo has traveled a safe enough distance from the submarine, the torpedo is activated so that it will seek out the ship at which it is fired.

YET, with its wire-guided underwater missiles, acoustic homing torpedoes, and electronic brains, the Navy is not satisfied with the torpedo guidance systems. Something better is needed. This problem assumes greater

The Astor is a wire-guided, wakeless, nuclear-warhead torpedo with long range and high speed.

Artist's conception of the Mark 39, an underwater guided missile capable of tracking and destroying its target despite countermeasures and evasive actions since it is zeroed in by electrical signals over the wire.

magnitude with every improvement in electronic and electromagnetic countermeasures.

JUST what the Navy is doing in its torpedo-guidance research programs is shrouded in classifications, but with the deadly kill performance made by aerial guided missiles having sensitive infrared instruments, the possibilities of developing infrared underwater missiles are not going to be overlooked by the Navy.

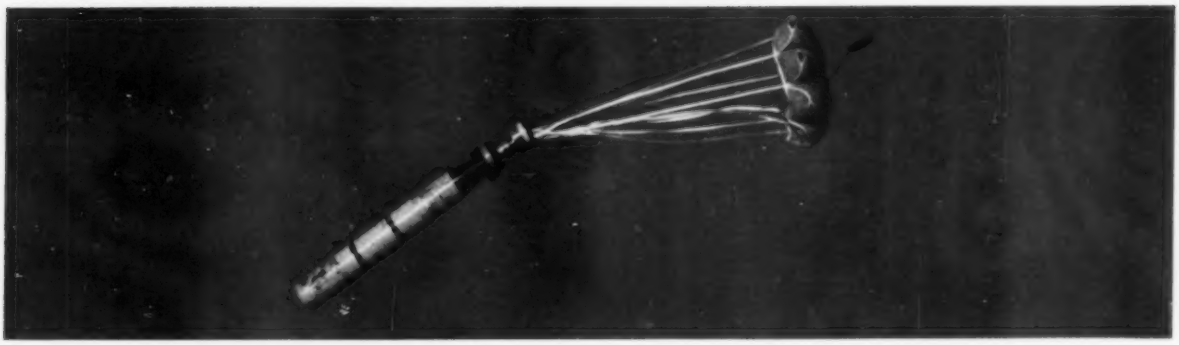
Research of infrared transmission in the ocean may result in the development of the ultimate in torpedo guidance. An infrared torpedo, immune to jamming, once its homing system had locked onto the target would destroy the enemy ship regardless of any maneuvering to escape.

Dynamics.—Since the torpedo is an extremely complex mechanism, the hydrodynamic shapes of future torpedoes will be affected by many things—including the size of the propulsion system, the automatic control elements, and the servomechanisms.

Reduction of weight of future torpedoes is an important part of the Navy's Retorc program. The main reason for this requirement is that both submarines and surface ships now must carry new and heavier equipment. There just isn't enough space for large and heavy torpedoes in future vessels. Thus, the future torpedo not only must be smaller but also must weigh less, yet meet these requirements without loss of performance.

These requirements steer the Navy toward a search for new lightweight materials in constructing its torpedo bodies. One such alloy, titanium, already used in carrier-based aircraft and missiles, is under consideration by Navy Ordnance experts.

RELIABILITY of torpedoes must be as close as possible to one hundred per cent. During World War II the Navy was frequently embarrassed by the failure of its torpedoes to explode upon contact with enemy ships. Some torpedoes exploded prematurely or passed directly underneath the enemy ship at anywhere from ten to fifteen feet below the depth for which they were set. Still



When air-launched, the Mark 44 torpedo is guided by a small parachute which is released on impact (all Navy photos).

other torpedoes would veer off course, completely missing the target.

While American submarines scored impressive sinking records of enemy ships during World War II, 37.5 per cent of their torpedoes failed to live up to their expected performance standards. An extensive development and testing system will assure almost one hundred per cent reliability in future torpedoes.

So much for the requirements and Navy research and development of the future torpedo. Here are brief sketches of the most important torpedoes now in use or under development:

Mark 32.—Lightweight, acoustic homing torpedo capable of tracking down and destroying submarines. Used by surface ships only. The Mark 32 does not have to be fired from a torpedo tube but is merely tossed over the side of a ship from an open launcher. Once in the water, its homing devices guide it toward the target.

Mark 35.—Acoustic homing torpedo used by surface ships against submarines.

Mark 37.—A submarine-launched, acoustic homing torpedo. Though primarily an antisubmarine weapon, it can be used for defensive purposes when the occasion arises. One of its most significant features is its ability to ignore many types of countermeasures. The Mark 37 is now undergoing refinements which will permit it to be fired from both submarines and destroyers.

Mark 39.—A wire-guided torpedo. The Mark 39 resembles a conventional model, but is actually an underwater guided missile capable of tracking and destroying its target despite countermeasures and evasive actions. As it drives through the water, operators aboard the launching vessel send electrical signals over the thin wire to guide the torpedo to a kill.

Mark 43.—A lightweight, acoustic homing torpedo which can be launched from both surface ships and aircraft. The weight is only about one-eighth that of World War II aerial torpedoes, and it is approximately eight feet long and ten inches in diameter. A new version of the Mark 43 torpedo is able to attack faster and search to greater depths for enemy targets. It is propelled by an electric motor which receives its power from a storage battery.

Mark 44.—An acoustic target-seeking, electrically propelled torpedo which can be launched or projected from either aircraft or surface ships. When launched from aircraft, a small parachute slows the fall. Upon impact the parachute is released and the torpedo starts its hunt. Powered by sea-water batteries, the Mark 44 is capable of attaining speeds and depths associated with nuclear submarines. An advanced version of the original Mark 44 torpedo is now under development.

Mark 46.—A lightweight, high-speed, acoustic homing antisubmarine torpedo and the Navy's first solid-propellant-burning torpedo in which gases from the propellant will drive the turbines. Now under development, the Mark 46, which will replace the Mark 44, is described as being "very fast" with "longer range" and will reach "great depths."

"To meet the advantages held by the modern nuclear-powered submarines, the Navy faces a great technological challenge in developing speedier, quieter-running, longer-range, and deadlier torpedoes. The research programs undertaken under Retorc seek to develop these new weapons."

Astor.—A long-range, high-speed, wire-guided wakeless nuclear-warhead torpedo for use by submarines against submarines and surface ships. This underwater guided missile has great reliability and long range. Measuring almost twenty feet, the Astor weighs more than a ton.

Torpedoes are also the warheads of two new antisubmarine weapons—Subroc and Asroc.

Subroc.—Is a missile which is fired from a submerged submarine, is guided through the air, and reenters the water near the enemy submarine target. Upon reentering the water, the spent rocket drops away and the warhead—a torpedo—continues on to the target. Subroc provides ranges greatly in excess of present antisubmarine torpedo ranges.

Asroc.—Is a similar system whereby the antisubmarine rocket is fired from a surface vessel. The missile, aimed with deadly accuracy by the shipboard digital fire-control system, follows a ballistic trajectory, shedding its rocket motor at a predetermined signal and its airframe shortly before water entry. The payload—a Mark 44 torpedo (the warhead can also be a depth charge)—is activated upon hitting water and heads toward the target guided by its acoustic listening system. The Navy intends to equip some 150 destroyers and cruisers with Asroc over the next few years.

Soviet Rocket Forces

The Communists have a complete arsenal of large and small weapons and it is believed that they could airlift some five nuclear-armed fully mechanized rocket divisions to very nearly any spot on earth

Alfred J. Zaehringer

THE Soviet rocket forces, with a single head, are operationally split up among other various operating arms. There is no separate rocket force, except on paper. It is certain, however, that rocket weapons have been receiving increasing attention, especially during the last ten years. It looks like the rocket forces have been integrated into a ground-oriented, army-controlled group.

In the U.S.S.R., there are really only two services—the army and the navy. By and far, the army is the most powerful and the largest military group, but the navy has moved up fast recently. The army is organized into these commands: ground, air, antiair, and rocket.

The Soviet Army is thus the dominant factor in all the armed forces. During World War II, for example, air and naval forces operated directly and solely in support of the ground force. And, at the present time, army commands incorporate both ground and air elements. It appears that the large rocket field weapons—up to say about 500 miles' range—would be attached directly to a particular ground arm, much as are air, antiair, and naval forces.

Soon after the end of World War II, development of the long-range rocket was centralized in an agency with Gen. A. S. Yakolev as director. This group was called the Office of Special Weapons and had its headquarters in Moscow.

Despite the screening praise given the ICBM by then Air Marshal Pavel Zhigarev in the 'fifties, it was certain that the rocket, just as the airplane, was looked on merely as an extension of artillery.

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It could be expected, therefore, that long-range missiles would soon fall under army control. This view finally was confirmed in 1960 when it was announced that Marshal Mitrofan I. Nedelin had been appointed as Marshal of Rocketry. Thus, on the surface, a new force had been created, but, in reality the army had again won out in a continuing power struggle.

Nedelin was said to have control of over 100 missile bases (IRBM and ICBM) with a force total of 200,000 men. In addition, Nedelin had direct charge of nuclear warhead factories, guided-missile plants, rocket-test sites, and ground-missile units.

If this were true, then Nedelin commanded a total of some half a million rocket people which not only included his rocket force but scientists, engineers, production workers, and administrative personnel.

Normally a marshal commands a front. The term front is somewhat analogous to our army group setup, and in wartime a front has a strength of 750,000 to 1,000,000 men. Using typical Soviet front organization charts, the rocket force, then, is likely to have the following full-strength major elements:

1. Two to four armies (fifteen to thirty-five rocket divisions).
2. One or two mechanized armies (four to eight mobile rocket divisions).
3. One or two rocket-equipped air armies (about 1,000 aircraft each).
4. One rocket artillery corps (eighty rocket battalions).
5. Ground-to-ground (tactical and strategic) and ground-to-air (antiair and antimissile) guided-missile units.
6. Twenty to forty rocket artillery battalions (regiment and brigade organization).
7. Five or six rocket antiair divisions.
8. Numerous bridging battalions, engineer brigades, road and railway construction units, signal regiments, and truck transportation brigades.
9. Miscellaneous replacement, security, and service elements.

THE rocket forces appear to be growing at a time when the Soviets claim to be cutting back in conventional forces. For the same reason it is just as hard to fathom military spending figures. The U.S.S.R. juggles its published figures for research and military spending.

However, it is estimated that for 1961 they upped their rocket spending by 18.7 per cent.

Total military effort (direct, education, research, and espionage) is stated to be 24.3 billion rubles (the new kind) for 1961 with weapons-support costs of 20 to 35 billion rubles, and a total of 42 to 59 billion rubles actually being spent. This is a lot of money considering that the official ruble is valued at $1.11.

IN the United States, missile commands are spread thin among the three services, not to mention several other administrative offices. With their strong centralization, it is no wonder that the Soviets have been able to make a significant time reduction between the design concept and operational status of military missiles.

On October 20, 1960, Marshal Nedelin was listed as a victim in an air crash while on a tour of duty. It has been reported that, at this time, the Soviets had a disastrous launch failure for some "spectacular" space shot, and some one hundred persons were reported to have been killed. Other top men reported dead at the same time were Deputy Chief of Staff Gen. Nikolai O. Pavolobsky and Deputy Chairman for the Atomic Energy Committee, Prof. Dimitri V. Effremov.

The present rocket commander is Marshal Kirill S. Moskalenko. This ground man also has a long-time standing in the military picture. Moskalenko joined the Communist Party in 1926 and was a commander of an infantry division during World War II. He was credited with helping to break the Germans in the Ukraine. In 1954, Moskalenko was elected as a deputy in the Supreme Soviet and by 1956 had a key position in the Central Committee. It was in 1956 that he became a Marshal and served as chief of the military garrison at Moscow.

Even before the emergence of a rocket force of the army, it was known that the Soviets slowly had been displacing conventional artillery with missiles. A good example of this is the T-5 system. While the U. S. was developing its unwieldly atomic cannon, the Soviets took two different approaches. They used a tube-type launcher for the German developed Rheinbote rocket.

Another variation was a rocket-boosted solid-fuel ramjet (also tube-launched). Both types, seen mounted atop heavy tanks, could give good mobility and have ranges of over one hundred miles while being able to deliver a small atomic weapon. However, it is certain that this was just a stopgap affair and was used in the interim while longer-range ballistic missiles were being developed.

Between World War II and Korea, specific rocket groups had been established. The rocket battalion of a typical mechanized division is equipped with a dozen 140-mm. rocket launchers. The standard tank rocket battalion has 230 officers and men and is equipped with a dozen 240-mm. rocket launchers mounted on standard trucks. Each mechanized army (composed of two tank divisions, two mechanized divisions, an antiair artillery division, and an artillery brigade) has a rocket-launcher regiment with about one hundred rocket launchers. Other known field rocket weapons include: the BM-13 (132 mm.), the BM-14 (150 mm.), BM-15 (200 mm.), and a newer large caliber (about 250 mm.) 6-round launcher. All these launchers are mounted on standard trucks.

A most critical factor in the rocket force picture is that of transportation. Russian roads are very poorly developed and handle only about 4 per cent of the total traffic. Strangely, airplanes handle an equal 4 per cent of the freight. Canals are a big item and carry some 12 per cent. The remaining 80 per cent of the freight is carried by rail.

THE railroads are well organized and even today are operated by the army—complete with uniformed personnel. Rails stretch from border to border (mostly as branches of the Trans-Siberian Railroad) but north-south nets are not well developed.

It can be expected that very heavy military equipment will be shipped by rail and that long-range missile bases will be located near rail lines (viz., at the east and west terminals for IRBM's, and along the southern borders for ICBM's).

It is interesting to note that the Soviets have mastered the bulk rail shipment of cryogenic fluids (such as liquid oxygen) for missile use. The railroad LOX car can carry 30,000 kg., tanks for flatcars (or trucks) can handle 1,300 kg., and trailer-truck tanks can carry a 6,000-kg. LOX payload.

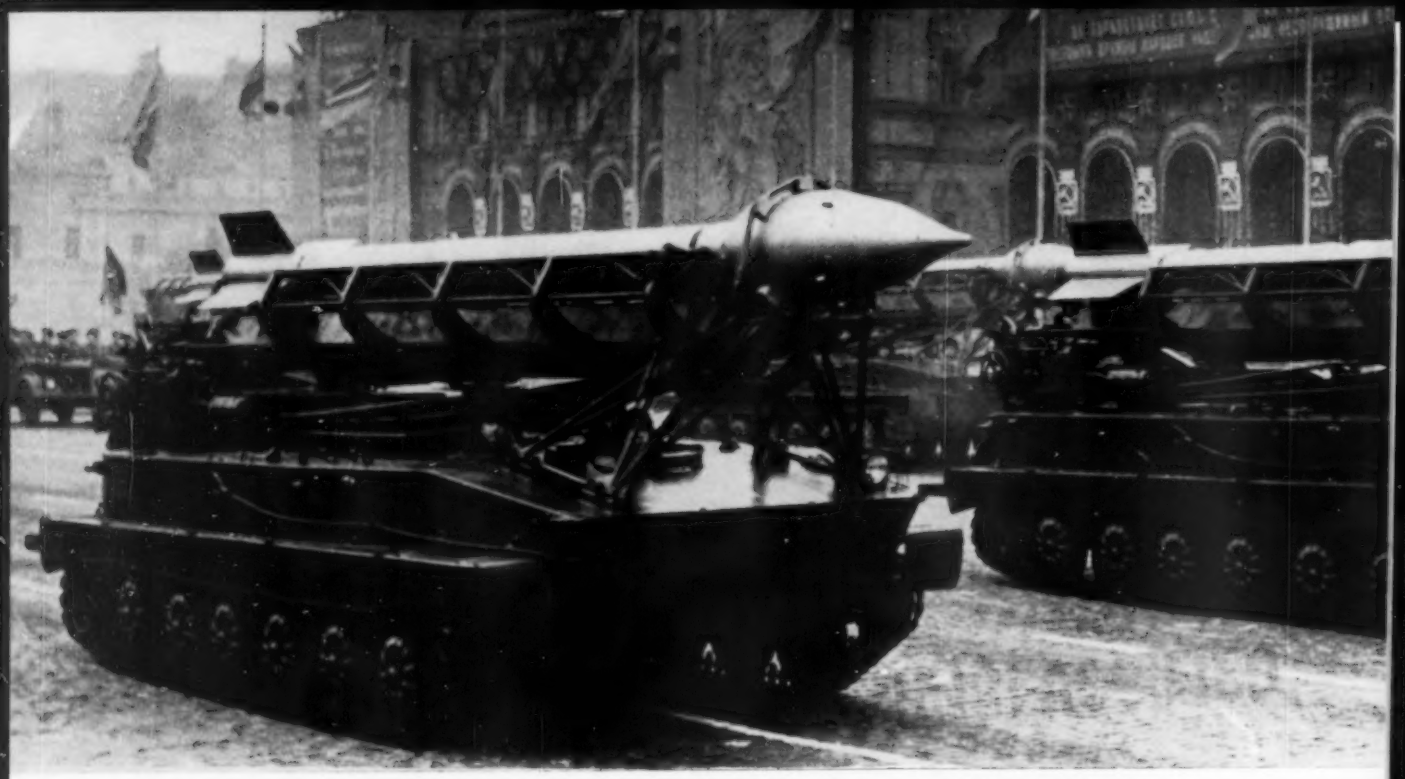
With regard to LOX, the Soviet ground-support equipment philosophy is to slap the tank on any available vehicle, giving an extremely unsophisticated but rugged, cheap, and reliable system. Boil-off losses, incidentally, are much higher in the Soviet system than are evident in ours.

SOVIET boxcars have capacities of 18 to 55 short tons, gondolas have 16½ to 55 tons, flatcars 18 to 66 tons, and tank cars 27½ and 55 short tons. A standard military train averages 600 to 1,000 short tons (with 120 axles) or, for heavy equipment, about 80 axles. The empty weights of the big liquid ballistic missiles are well within the load-carrying capabilities of flatcars. In addition, it is believed that these big missiles were broken into stages for ease in transporting them from factory to launch site.

The Soviet armed forces, then, still depend heavily on rail transportation. However, all the ground forces are equipped with trucks of modern post-war vintage. Each army has a transport regiment consisting of some 900 to 1,000 trucks. In addition, some 30 per cent of the trucks in line outfits now haul trailers. Many specialized trucks and vehicles for missile use have not appeared as they have in the United States.

All efforts have been expended on the missiles themselves—it is no wonder that the Soviets have been able to reduce lead time. Despite the fact that civilian goods are often primitive and slipshod in construction, most military people agree that the reverse is true of Soviet military items. The theoretical approach is taken on the design and construction of military equipment, especially with aircraft and missiles.

Because of the weak transportation



Soviet rocket forces in past years included this 15-mile rocket on an amphibious tank chassis.

net, the Soviets have resorted to a stockpiling program to minimize the effects of any possible strategic bombing. All military districts have to maintain a 60-combat-day stock of material and munitions in their depots. The central reserve depots are under the jurisdiction of the Ministry of Defense, Main Directorate of State Material Reserves. Each year the Presidium of the Communist Party determines the portion of production to be allocated to armed-forces consumption and that to be held in reserve.

THE antiair force has been completely modernized with rockets and there are three main weapons: barrage flak, guided-missile AA, and antimissile.

The T-6 or M-2 is a fully mobile antiaircraft system that is somewhere in between our Nike-Ajax and Nike-Hercules systems with regard to capability. The T-6 has two stages, is all-solid-propelled, and has an estimated 25-mile slant range and about a 50,000- to 70,000-foot service ceiling.

The mobile system is tied into an extensive radar network, each radar zone covering several hundreds of kilometers of airspace. These zones are formed into a unified radar field and the fields cover all borders of the U.S.S.R.

It is becoming increasingly apparent that the Soviets are becoming more touchy about even close approaches to this network. The Soviets claim that they could spot a "metallic flea" in the stratosphere via their radar.

Head of the antiair forces is Marshal Sergei S. Biryuzov who took over in 1954. Marshal Biryuzov also reveals how rockets helped cut down the manpower requirements of the armed forces. One rocket manned by a crew of three could take the place of a conventional antiair-artillery battalion of 600 men!

Since at least 1957, the Soviets have been developing an anti-ICBM system which could be integrated into the antiair rocket forces. Some of the problems, however, were outlined by Engineer Maj. V. Kriksunov. Radar detects the ICBM at a range of 320 miles and via a computer predicts the target. The computation must be completed in 60 seconds. To destroy an ICBM some 50 miles from its target, the antimissile has to be fired while the ICBM is still 169 miles away. This leaves some 25 to 30 seconds for the computer to solve an intercept trajectory for the "anti."

Therefore, detection at ranges of 810-1,000 miles would be much better. The 1957 "anti" was looked on as a 3-stage all-solid rocket with first-stage thrust of 308,000 pounds, total launch weight of 95,500 pounds, a third-stage weight of 945 pounds, and a total powered-flight time of only 30 seconds. The 1957 detection accuracy for radar of 1,000 miles' range was stated to be within one per cent, or 10 miles. Assuming a 20-kiloton warhead for the "anti," the Soviets say that the intercept would have to be better than 985 feet.

It is stated by reliable sources that the Soviets have instituted an all-out "crash" anti-ICBM program. Indicative of one phase of this program is the 2 billion rubles a year the Soviets will spend for advancing "electronic information processing digital computers," a vital cog in the present view of an antimissile program.

HOWEVER, the antimissile program probably will be limited by electronics rather than by propulsion.

Soviet rocket forces attached to regular ground units employ solid rockets: (1) the T-5B, 15-mile range, with nuclear warhead, similar to our Honest John but riding atop a tank chassis; (2) the T-5C, a 5- to 10-mile-range smaller version of the T-5B, also tank-carried; (3) the T-7A, with 50-mile range, atomic warhead, tank-carried, and similar to our Sergeant; and (4)

the T-7B, a 100-mile version in the near Pershing class.

The CH-17, CH-18, and CH-19 are under development ultimately to replace large liquid IRBM's. These solid rockets also are being used currently to equip a nuclear submarine striking force.

HOWEVER, even though these missiles may be used by the Navy, it looks like they were designed as multiple-purpose items. They can be used ultimately for the IRBM, big space "Jato's" or boosters for liquid rockets of ICBM size, and, eventually, lead to an all-solid ICBM. There is very good reason to believe that the Soviets have been working on a solid-propellant ICBM for quite some time.

The big stick of the Soviet rocket force is still vested within its arsenal of liquid ballistic missiles. The T-1, similar to our Redstone, is the only one which has been seen by "unclassified" Western eyes. It is therefore to be regarded as obsolete and actually may be in the hands of some satellite nations, including Red China.

The T-1, with solid-rocket upper stages, could, for example, allow the Communist nations to establish their own "satellite club." The Soviets have been helping Red China for some time in both satellite and A-bomb programs. Here, with obsolete weapons, the U. S. could soon be shocked by a "satellite's satellite" or, even worse, be caught with its "policy down" should country X decide to bombard country Y with conventional high explosives from a range of 250 to 500 miles.

THE IRBM, T-2 is now fully operational and sited at about twenty "soft" but fully mobile bases. Like the antiair rocket, the T-2 appears to be shifted around constantly. It may have been for this reason that the Soviets allowed overflights of the U-2 for such a long time.

The IRBM bases are located at Kola, Ostrov, Ozera, and Ust-Taimyra (targets in Britain and Scandanavia); Bobruisk, Kazan, Kuressaare, Lada, Luga, Minsk, Odessa, Roslovl/Kirov, Riga, and Yelgava (targets in Europe, Northern Africa, and the Middle East); and Anadyr, Irkutsk, Komsomolsk, Korsakov, Mil'kovo, Nikoleavsk, Okha, Omsk, and Terpeniye (Alaska, Okinawa, and Asian targets).

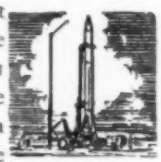
The ICBM, T-3, however, is probably so large (launch weight, 180,000 to 190,000 pounds) that it is probably sited into "hard" underground bases. Some 10 bases, said to be hardened to 125 p.s.i. overpressure, are believed to be operational. The ICBM bases are reported to be located near Alma-Ata, Anadyr, Aralsk, Irkutsk, Kapustin Yar, Komsomolsk, Magnitogorsk, Mid Kalinin, Murgab, and Okha.

With the up-and-coming long-range solid rockets, the existence of the "big jobs" probably will mean an increased tempo of space activity. It is not difficult to see that the Soviets already have mapped out a military space need and that this military space program will be dominated by the Red Army. It is not difficult, then, to expect that in the near future the Soviets will announce a "Space Force" commanded by some army marshal!

Hard on the heels of a Soviet man in orbit and his successful recovery, the Soviets are talking about an initial 60-ton space station which can be manned by several persons. And the Soviets are planning self-sustaining lunar bases which would be established within this decade.

Thus, following establishment of an American military space capability, it is not hard for one to visualize a Soviet "antispace force."

A clue into future Soviet military space capabilities was recently given at a hearing of the Senate Armed Services Subcommittee on Military Construction. According to Brig. Gen. J. T. Snodgrass, the next decade will show the following: (1) In 1961 the U.S.S.R. will place the U.S.A. under a serious ballistic-missile threat; (2) By 1963 the U.S.S.R. will have the ICBM as its major delivery system; (3) In 1965 the U.S.S.R. will offer a military satellite threat; (4) By 1966-1967 the U.S.S.R. will have an operational hypersonic bomber (of the satellite or boost-glide type).



What is the present missile strength of the Soviet rocket force? We can't be sure, but from capabilities and the available time a "guesstimate" of sufficient accuracy can be made. All told, in just the big "jobs," it looks like there is a need for a total stockpile of 1,000 IRBM's and ICBM's, with perhaps one half ready to go at any one time.

The total nuclear yield of the U.S.S.R. in IRBM's alone is estimated at about 6 billion tons. For the ICBM, it would be on the order of 12 to 25 billion tons. Altogether, with the much more numerous battlefield rockets, the total yield might be estimated at about one teraton—or equal to one trillion tons of TNT.

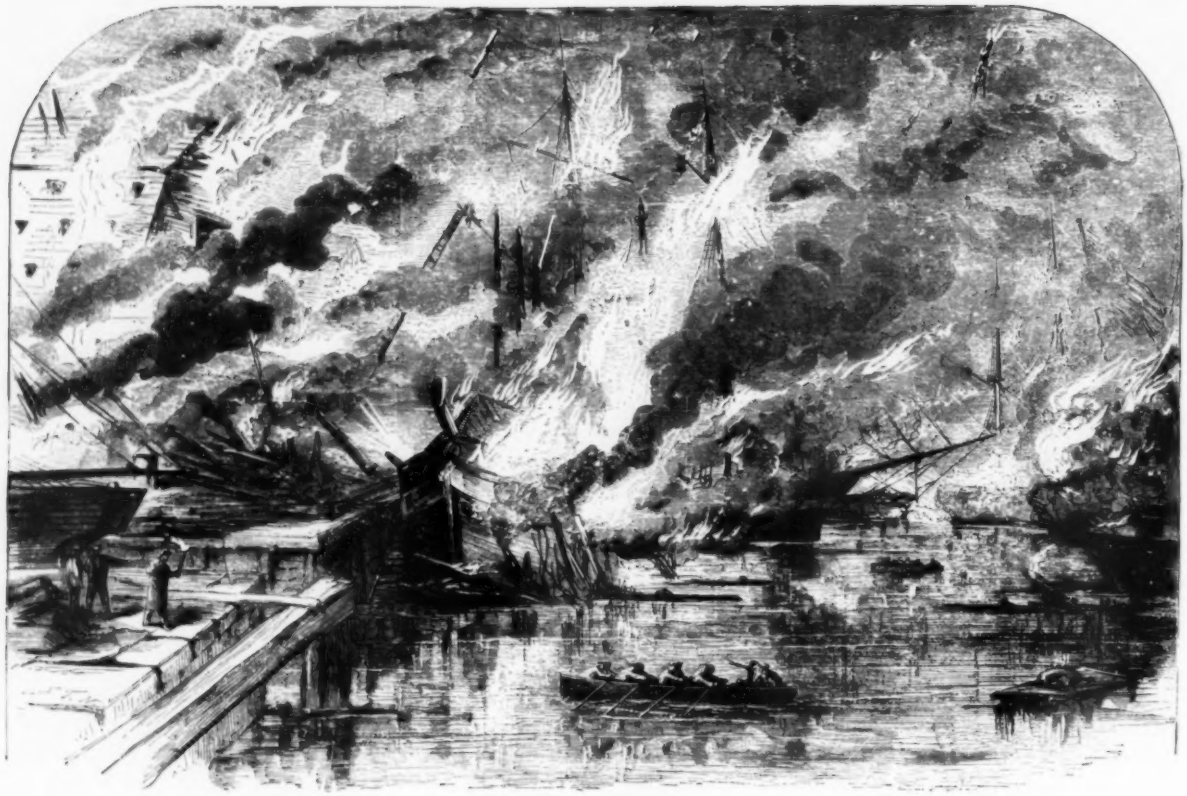
TO give some idea of this order of magnitude, the U.S.A. uses over one billion pounds of commercial high explosives a year, or roughly a million tons. The total nuclear yield of the Soviet is thus equivalent to about one million times the power of one year of commercial blasting.

Could this tremendous power destroy the world? No! It could damage much of Western industrial and fixed military targets but could not achieve a decisive victory without accompanying military and political operations.

Nevertheless, the Soviets appear to be preparing not only for an all-out war but also have equipped their forces with new rocket weapons for limited wars. With the constant research push, the standard rocket weapons of yesterday can be expected continually to upgrade the force potential of her allies. The single-command concept, within an already all-centralized, powerful army, is designed for speedy activation and operation.

In addition to heavy reliance on wheels for rocket movement, many of the smaller rockets weapons (of respectable nuclear yield) are designed for amphibious and airborne carriers. It is estimated, for example, that the Soviets could airlift to any spot on the earth some five fully mechanized, rocket- and nuclear-equipped divisions.

Perhaps the United States had better think about a little more boot filling rather than boot trembling. We have been challenged, and we must meet the challenge to survive!



THE BURNING OF THE NORFOLK NAVY YARD, THE FRIGATE "MERRIMAC," AND OTHER VESSELS, APRIL 21, 1861.

Loss of the Norfolk Yard

Rear Adm. John D. Hayes

IT is tempting but useless to speculate on what might have happened had the Union forces endeavored to hold the Norfolk Navy Yard instead of abandoning it, or if the Virginians had prevented the destruction of the ships and thereby started with a sizable navy as well as an outstanding naval base. Norfolk on the Union side was sacrificed because Fortress Monroe had to be held.

This decision was made by Lieut. Gen. Winfield Scott. His instructions to Captain Wright, who was assigned command of the defenses at Norfolk Navy Yard, were specific. "Both of you," he wrote, including Colonel Dimick, the commander at Fortress Monroe, "will bear in mind that although the Navy Yard and its contents are deemed to be of great importance, Fortress Monroe is still more so to the Union."

Admiral Hayes is a well-known consultant on naval history. Before his retirement, he was on the faculty of the Industrial College of the Armed Forces, Fort Leslie J. McNair, Washington, D. C.

The Virginians also had to take first things first. Their State, as soon as it seceded, would be open to attack from the North by land and sea. Norfolk with its ships, its guns, and its powder therefore appealed to them more than did the strategic position of Fortress Monroe.

THE whole pattern of the war may thereby have been settled on its first day. The holding of Fortress Monroe by the Union determined its final outcome. The abandonment of Norfolk to the Confederacy determined its protraction.

Norfolk, or Gosport Navy Yard as

it often was called at the time, was located then in the same place it is today, on the south branch of the Elizabeth River, a nautical mile below the city and twelve from Fortress Monroe, which guarded the entrance to Hampton Roads. The Navy Yard's location enabled it to command and protect the most spacious roadstead on the coast as long as it was amply covered and shielded from external assault by the guns of Fortress Monroe.

THE Yard had a large graving dock, and its shops and storehouses were full of equipment and supplies, most of which were produced in Northern States. A Marine barracks was located in the center of the Yard, and across the river almost twelve hundred pieces of ordnance were stored, over fifty of them being large Dahlgrens of the latest type.

War vessels at the Yard included the ship of the line PENNSYLVANIA, a 4-decker, pierced for 120 guns, used as a receiving ship or naval barracks; eight other sailing ships, one of which was the rebuilt UNITED STATES of War of 1812 fame; and the fine steam frigate MERRIMAC. All were out of commission.

At Norfolk there also was the naval hospital, directly opposite the city; and a naval magazine at Fort Norfolk, at the foot of present Colley Street, where loaded shells and 2,800 barrels of powder, 100 pounds each, were stored. The 24-gun sailing sloop of war CUMBERLAND, in full commission, was anchored just off the city.

The Commandant of the Navy Station at Norfolk was Commodore Charles McCauley, 68 years old and with 52 years of naval service. All the other officers there, with a few exceptions, were natives of Virginia and Maryland.

Our story starts on April 10, 1861, when Secretary Welles in his own handwriting prepared his first letter of instructions for the Commandant at Norfolk.

Lincoln was careful that Virginia would be given no cause or justification to secede, and therefore Welles had to be circumspect in the orders he gave McCauley regarding the MERRIMAC and others ready there. He stated in his carefully worded letter of the 10th that it was "deemed important that the steamer MERRIMAC should be in condition to proceed to Philadelphia or any other yard, should it be necessary, or, in case of danger from unlawful attempts to take possession of her, that she be placed beyond their reach."

In the same letter he added "It is desirable that there should be no steps taken to give needless alarm, but it may be best to order most of the shipping to sea or other stations."

Such were the instructions that a "do-nothing" Secretary sent to the man of whom another naval officer had written three months before: "The Commander there [Norfolk] is the weakest of the weak."

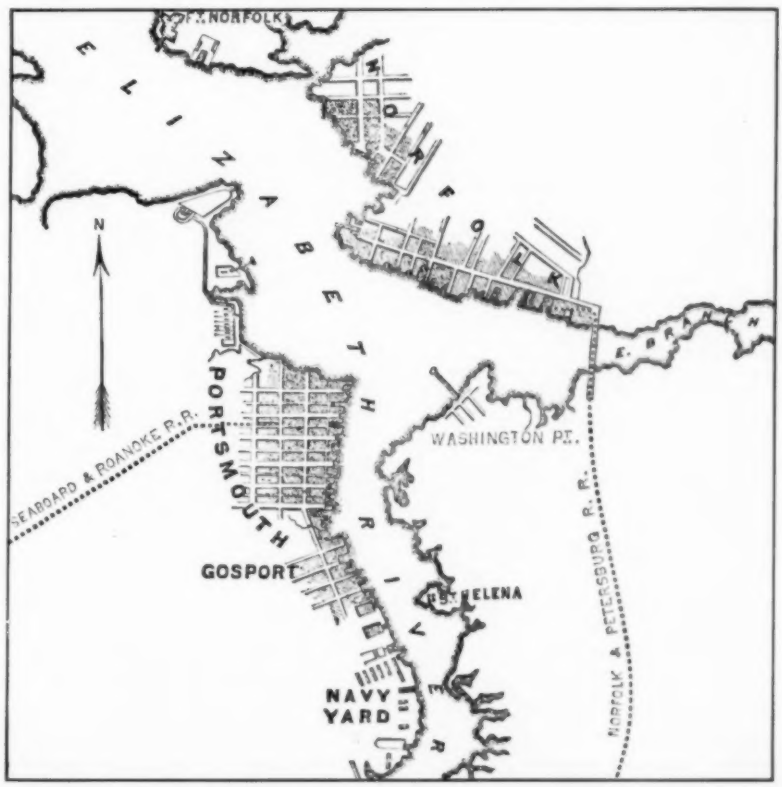
On April 11th, Comdr. James Alden, then in Washington, was given confidential orders to take charge of the MERRIMAC and deliver her to the Philadelphia Navy Yard, and a routine order was sent to Norfolk to have her prepared as soon as possible with instructions to inform the Department when the vessel would be ready.

The next day the Commandant telegraphed the Navy Department that the Chief Engineer of the Yard, Robert Danby of Delaware, reported that it would take one month to prepare the MERRIMAC's engines. This answer did not satisfy the newly appointed Engineer in Chief of the Navy, Benjamin H. Isherwood, an able, dynamic, bouncy individual with a penchant for needling his stuffy seniors, especially if they were line officers.

He wrote out the draft of a confidential order for Welles to sign ordering him to Norfolk to hurry the assembling of the MERRIMAC's engines. He arrived at the Navy Yard on Sunday the 14th. In three days, with Danby's help, he had steam up in this ship.

MEANWHILE, a few days before Virginia seceded, the tug TEASER, William H. Face, master, was sent from Richmond to assist secessionists there in blocking the channel to Hampton Roads. Early in the morning of April 17th three lightboats were towed out and sunk in the channel between Craney Island and Sewell's Point.

The masts of the sunken craft could



The Norfolk Navy Yard's location made it vital to the Union and Rebel forces.

be seen above water, and this bad news was conveyed to Commodore McCauley in the morning. A party from the CUMBERLAND sounded during the day, and it appeared that unless more craft were sunk, the MERRIMAC could still get out.

In Washington, General Scott was sending daily written reports to the President, including plans for using naval forces. Scott asked for a small war steamer to cruise between Alexandria and the Long Bridge for the Marines to assist in the defense of the Capital, and he suggested that the spare Marines from the navy yards at Philadelphia, New York, and Boston be sent promptly to Gosport.

Word had been received in Washington, evidently from Alden or Isherwood, of McCauley's vacillations under the pressure of his Virginia officers. Welles turned to Commodore Hiram Paulding of New York whom he had assigned to the Department about the end of March when the Secretary at last realized that he must have near him a senior officer whom he could rely on and trust.

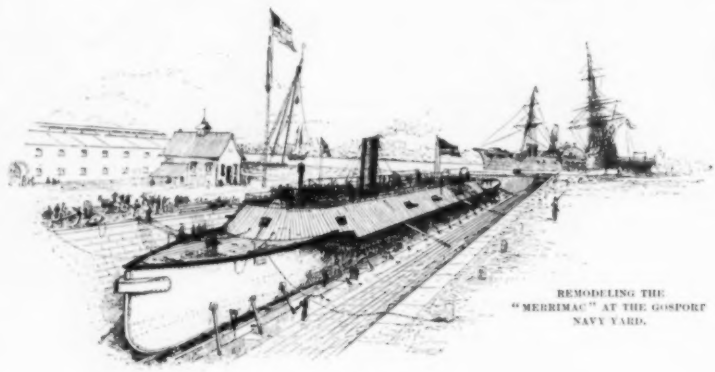
It was decided that Paulding should go down and bolster the old man who also would be directed to confer with Commodore Pendergrast, the Commander of the Home Squadron, in the CUMBERLAND.

THE Secretary wrote another letter to McCauley, almost as weasling as the first, and also one to Pendergrast. Paulding carried both to Norfolk. He took along Comdr. Thornton A. Jenkins, a Virginian on duty in Washington who was outspoken in his loyalty to the Union. Jenkins, respected in the Navy, might be able to keep his fellow Virginians in line.

Paulding and Jenkins, after they arrived in Norfolk on April 17th, found they could do little. At Paulding's suggestion the CUMBERLAND was moved to a berth off the Yard where Pendergrast would be better able to support McCauley, both mentally and physically. The Virginians agreed to this since the city would no longer be hostage to the CUMBERLAND's guns.

But Paulding could not expedite the departure of the MERRIMAC. Her engines were ready but such steps as warping her to put her head downstream could be seen outside the Yard and would give offense.

Alden and Isherwood remained, but they had no more success on Thursday, April 18th, in readying the MERRIMAC than Paulding. They obtained a small amount of coal and enough men to take the ship as far as Fortress Monroe. But no pilot in Norfolk would give his services, and the obstructions sunk in the channel gave McCauley an additional excuse for doing nothing. There was nothing for Alden and Isherwood to do now but carry this sad news to Washington.



REMODELING THE "MERRIMAC" AT THE GOSPORT NAVY YARD.

On Thursday the Virginia officers submitted their resignations, but the next day before dawn they found themselves subject to a new authority.

On Wednesday, April 17, 1861, the day Virginia seceded, Lieuts. Robert B. Pegram, Catesby R. Jones, and James H. Rochelle, U. S. Navy, were called to Richmond from the Navy Yard. That night they submitted their resignations and the next day accepted commissions in the Virginia Navy from Governor John Letcher. Catesby Jones even took one along for his friend, Lieut. George T. Sinclair, assistant ordnance officer at the Navy Yard.

The senior of the three, Pegram, received orders to assume control of the naval station at Norfolk and provide for its naval defense. Thursday night they departed in a special train, arriving about 3 a.m. the next morning. With them were William B. Taliaferro, the senior militia officer of Virginia, who had orders to take command of the Virginia troops in Norfolk, two aides, and William H. Mahone, president of the Norfolk-Petersburg Railroad and an ardent secessionist. George T. Sinclair was routed out of his bed before dawn to make the major decision of his life.

Catesby Jones and Terry Sinclair had a job to do. General Taliaferro, whose troops at that time consisted of but two companies of militia, received a telegram from the governor shortly after he arrived in Norfolk. "As we need powder, keep an eye for the article." Jones and Sinclair planned to get it that night with the help of Captain Face of the TEASER, the Norfolk volunteer firemen, and some militia.

At 8 p.m., Sinclair, in the name of Pegram, arrested the lone custodian of the magazine at Fort Norfolk, his former assistant, Gunner Charles B. Oliver. That night, 1,300 barrels of powder were loaded on barges and sent to Richmond without knowledge of the undertaking reaching the Navy Yard. The rest, 1,500 barrels, were loaded on wagons and taken inland.

MCCAULEY was now left in the Navy Yard with only two line officers. Telegraphic communications with Washington were cut off. He still had the Marines of the Yard and a few Marines and sailors in the receiving ship, plus Pendergrast and his CUMBERLAND. That afternoon the guns in the gun park across the river were ineffectually spiked with wrought-iron nails, all that was available, and the ships prepared for scuttling in case that should be necessary.

With practically no military means, the Virginians could only bluff or, in today's Pentagonese, "conduct psychological warfare."

On the morning of the 20th, William H. Mahone took a locomotive and a flatcar along his tracks toward Suffolk to investigate a rumor that the railroad bridge across the Elizabeth River below the Navy Yard had been destroyed. Finding the bridge intact he continued on as far as the Dismal Swamp.

On his return he executed his first piece of strategy for the Confederacy. He ordered the engineer to blow the whistle and ring the bell of the locomotive in such a manner as to give the impression of several trains approaching the city. This artifice continued during the day and into the night with enthusiastic shouters riding the cars.

The most damaging piece of misinformation reaching McCauley came from the CUMBERLAND. About noon on Saturday, the 20th, the masthead lookout reported batteries being thrown up on the other side of the Elizabeth River. There is nothing in the record that indicates this report was checked before it was sent to McCauley. The Commandant sent an officer to Norfolk under a flag of truce to demand that the work be stopped. Taliaferro had heard nothing about this, so he sent his aide, Captain Heth, later a Confederate general, out to see McCauley.

Heth would neither admit nor deny that the batteries were there, and then McCauley panicked. The MERRIMAC was ordered scuttled, and the giant shears, used to lift guns and masts into ships, were cut away, crashing down on the GERMANTOWN, also ready to sail. This was the act that set off the chain of events which ended with the ironclad MERRIMAC destroying a brave but helpless CUMBERLAND almost a year later.

MCCAULEY during this time was ignorant of what was going on in Washington and nobody bothered to inform him. On the 17th, Scott had reported to the President that when a regiment from Boston arrived at Fortress Monroe he might be able to spare some troops and a capable engineer to supervise the defenses for the Norfolk Navy Yard.

After Paulding returned with the news that Virginia had seceded, Welles wrote the type of orders he should have written to McCauley a week before. These orders placed Paulding in command and directed him to get the ships and other U.S. property at Norfolk beyond danger or destroy them.

PAULDING sent orders to New York, Philadelphia, and Baltimore for seamen and ships, and all officers in Washington were alerted to be ready for emergency duty. The Navy Yard prepared an order for combustibles, including twenty barrels of powder, and Captain Wright, the assistant to the Chief of Engineers, was ordered as the Army commander in charge of defenses. Everything was ready but a man-of-war.

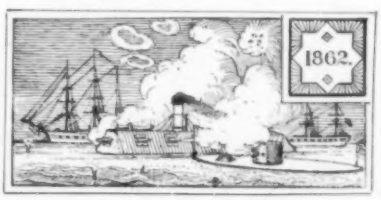
The next morning, the PAWNEE under command of Stephen C. Rowan appeared, returning from the abortive Fort Sumter expedition. Lincoln wanted her for the patrol of the Potomac that Scott had recommended and Paulding could only obtain her after earnest solicitation and with the promise to return her at the earliest practical moment. This reservation destroyed whatever chance the mission ever had of succeeding.

The PAWNEE, crowded with officers, Marines, and gear departed about sundown and arrived at Fortress Monroe about 2:30 p.m. the next day, the 20th.

The 3rd and 4th Massachusetts were now at the fort, the 3rd having arrived that morning. This regiment, about 400 strong, squeezed aboard the PAWNEE. It was 8 p.m. when the PAWNEE, passing Norfolk with her guns shotted, appeared off the Yard.

There is no need to recount here the fruitless efforts of the next eight hours. They are all in the "Official Records of the Union and Confederate Navies," first series, Vol. IV, pp. 289-298. Their complete failure was already determined by the events that had preceded them.

The blame for Norfolk, if there is blame, rests with Lincoln, Welles, and McCauley. It also rests with Congress which for half a century refused to make the organizational reforms in the Navy Department that would have kept a man like McCauley out of such a responsible position or would have prevented Welles from drifting in office for a month without professional advice such as General Scott was required by statute to give the President and Secretary of War.



The sinking and burning of the MERRIMAC turned out to be an assist for the Confederates. Sunk in shallow water, she burned only to her gun deck. After being raised, she was put into the drydock which Wright and Rodgers had failed to blow up. There she was cut down one more deck and an iron casemate built on her.

Even though her battle with the MONITOR was a draw and she was destroyed by her own crew after a commissioned life of only two months, she nevertheless started a chain of events that brought on McClellan's defeat and kept Richmond safe for two more years.

Before that, at Bull Run, the Confederates defeated a Union Army with U. S. Navy powder captured from the magazine at Norfolk by Virginia naval officers.

HOWEVER, most important of all in lengthening the war were those 1,200 pieces of ordnance. Some of them closed the rivers of Virginia, thereby enabling Robert E. Lee to carry the conflict inland and tie down the huge Army of the Potomac to the defense of Washington.

Union naval officers, some of whom had been at Norfolk, had to recapture these guns in hard fighting against forts along the Atlantic and Gulf coasts and on the Mississippi River.

"Great as was the loss of the ships," wrote David D. Porter a quarter of a century later, "it was much less than the loss of guns."

Editor's Note.—The drawing on page 220 is reproduced from "Naval History of the Civil War"; the map on page 221 is from "American Conflict"; and the sketches on pages 222 and 223 are from "Battles and Leaders of the Civil War."

The Air Force Makes Ready

The armament pod of the B-58 Hustler bomber, above, nestles into the canoelike cavity of the larger fuel pod which is jettisoned before an attack. Below, the F-106 Delta Dart all-weather interceptor is being loaded with the solid-propelled air-to-air Genie rocket which has an atomic capability. The B-58 has a speed of 1,300 m.p.h. and the F-106 of 1,500 m.p.h.

Defense Highlights: Monthly Review and Outlook

• **National Defense Spurred.**—The excitement over President Kennedy's urgent appeal to bolster national defense to the tune of an additional $3 billion has moderated. Actions taken indicate more concern with a broad permanent increase in strength than a rush to build up our NATO forces.

For the immediate situation the Air Force did alert seventy-one Air Guard and Reserve units, warning them to be ready for active duty. Interceptor squadrons, transport wings, communication and radar units were called. The Navy is holding up "moth-balling" of some amphibious and ASW ships, and the Air Force has canceled deactivation of B-47 bombers.

The personnel increases authorized by Congress will come mostly by recruiting and the draft and ordering a few Reserve specialists to active duty, although Defense Secretary McNamara has said he will hold back the full increase authorized.

Air Force and Navy numbers, needed specifically for the aircraft and ships retained, will be almost as the President stated. The Army, already 12,000 below its old authorized strength, is being curtailed more drastically to 93,000 (instead of the one-million-man increase authorized). But this will enable it to put forces already in being in a combat-ready status, especially the 1st and 2nd Infantry and 2nd Armored Divisions now used for training. It won't allow any increase in the number of divisions.

The build-up in material for the long pull is earmarked for conventional warfare—more ammunition, tanks, rifles, vehicles, and infantry missiles for the Army; more carrier aircraft and air-defense missiles for the Navy; and more close-support F-105 aircraft for the Air Force.

However, much of the increased appropriation is going for "stopgap" measures. These include holding up deactivation of B-47 bombers and old transport aircraft and the return to service of moth-balled Navy transports and ASW ships.

Congressmen refused to be daunted by the Administration's lack of interest in more heavy bombers. They insisted on keeping in the Defense bill about half a billion dollars for additional B-52's or B-58's, although Secretary McNamara says the money won't be spent.

Thus Congress literally crashed through with the appropriations and personnel increases requested while Congressman Vinson, Chairman of the House Armed Services Committee, said: "If this is the strength figure necessary to maintain peace we must maintain (this strength) until the peace of the world is assured beyond doubt." He noted that the ups and downs of our military posture "look like a profile of the Rocky Mountains."

Perhaps the chairman knows a member of the Ordnance Association who did Herculean work during the "blood, sweat, and tears" days of World War II and long before, and who recently gave this analysis of what generally happens when emotional America goes to war:

1.—Smug lethargy turns into impatient and critical enthusiasm.

2.—We start overestimating our enemies and underestimating ourselves. We get panicky and start yelling for somebody to do something. The President, the Congress, and the politicians start demanding that everybody do the impossible.

3.—Mature experience becomes a handicap.

4.—Calm judgment goes out the window.

5.—Hysteria moves in—the sky is the limit.

6.—Johnny-come-lately opportunists take over.

7.—Result—we win as usual at *double* the cost.

8.—Then we throw away our victory at the peace conference.

• **Admiral Burke Retires.**—Adm. Arleigh A. Burke has stepped down as the Chief of Naval Operations after serving in that office for a record six years. He has set a mark of tireless devotion to his country and the Navy that is without parallel—and during a period of technological advances that have never been equaled.

In turning over his command to Adm. George W. Anderson, the retiring CNO reported: "The fleets are manned and ready, courageous captains and crews are ready for battle, our Navy is strong and alert, and all hands stand ready for the challenges that lie ahead."

A few days later, speaking as a "private citizen" (there are certain restrictions) he noted in referring to the present tension over Berlin, "Our firmness, of course, will involve substantial risks—tremendous risks—but we must accept them." The Communists are "well aware of our tremendous strength. They question only our willingness to use it."

To anyone who might be tempted to miscalculate this mood, Admiral Burke advised that he look at the United States responses in wars of the past "before he projects himself into a fearful future."

• **Project Vela.**—The Atomic Energy Commission's testing personnel have been busy, in spite of the test ban, preparing for possible atomic shots to test inspection devices (Project Vela) and the peaceful uses of atomic explosions (Project Plowshare). Underground tunnels in the Nevada Range are being cleared out and tunnels excavated in New Mexico and Mississippi.

AEC scientists in Project Vela are ready to proceed on about twelve underground nuclear blasts of various intensities. They have prepared numbers of mobile seismographic

stations to "read out" the earth shocks in our continuing search for a means to detect muffled underground tests and distinguish them from earthquake tremors.

Scientists reported recently to Congress that they had no solution yet to reliable detection of clandestine underground nuclear explosions. They appeared to be noncommital over the prospects of new findings even if the nuclear Vela tests are conducted.

Project Plowshare includes a massive blasting in Alaska to test the feasibility of forming artificial harbors together with a series of small tunnel blasts to study the practicability of producing steam when water is poured over the molten residue of the explosions.

AEC spokesmen point out that the tunnels may also be used for testing new weapon developments without danger of fallout.

• **Tiros and Trawlers.**—Angry cries of "spies" by the Communists followed the launching of Midas, a reconnaissance satellite, and Tiros a weather-observing and -reporting satellite. Both orbit over Soviet-held countries about once every third day. The Soviet Union even had been invited along with other Nations to participate in our Tiros experiments.

The United States should be amused since Soviet trawlers, profusely equipped with electronic gear, were observed "fishing" in the area of our latest Mercury astronaut flight.

• **Army Division Reorganization.**—The Army plans to start reorganizing its divisions early in 1962, although there is a rumor that Gen. Maxwell Taylor, military adviser to the President, may object. He supported the change to the present pentomic-type division.

The change is to permit flexibility in the manning and arming of a division for any eventuality, building up from a common division base. The division base will comprise (1) a division headquarters and three brigade headquarters; (2) a combat element of division artillery (105-mm. howitzers, medium artillery, and missiles) and an air-reconnaissance squadron of three units; (3) a combat support element consisting of one battalion each of engineer, signal, and aviation troops; and (4) a division support element comprising a headquarters and an administrative company and medical, transportation, and maintenance battalions.

The personnel and equipment in many of the support units will vary according to the "mix" of combat battalions in the divisions.

There will be four types of divisions—Infantry, Armor, Airborne, and Mechanized—assigned varying numbers and types of infantry, tank, parachute, and mechanized infantry battalions.

The division structure can be arranged to meet the general conditions it will be expected to face; *i.e.*, a predominance of parachute infantry in STRAC divisions, great strength in armor for Europe, or mostly infantry in the southeastern part of the Far East. The usual strength will be 15,000 men and officers.

Within each division there also may be considerable flexibility in the make-up of each brigade by interchange of battalions and wise use of the division base elements.

• **More Polaris Submarines.**—Ten Polaris-firing submarines recently ordered by the Navy complete the total of twenty-nine envisioned by the present Administration. Fourteen others are building, five are in commission. Congress authorized the Navy to buy long-lead-time items for additional submarines, yet no funds were earmarked for that purpose. Naval officials note that there will be a "Polaris gap" in their goal of forty-five unless they continue the program.

The Communists may have caused a reexamination of the 29-vessel limit since they claimed to have a bigger fleet of atomic-powered, rocket-firing submarines than the United States. However, only a few conventional submarines were on view at a recent Soviet naval demonstration of about sixty ships in Leningrad.

To meet 2-ocean needs, there eventually will be two squadrons of Polaris submarines stationed in the Pacific.

• **Space Detectives.**—The Space Detection and Tracking System Center (SPADATS) for the United States has started operations near Colorado Springs in the North American Air Defense Command's Combat Operations Center. Information from the Space Surveillance Facility (SPASUR), Naval Weapons Laboratory, Dahlgren, Va., on "dark" satellites and from the National Space Surveillance Control Center (SPACETRACK), Hanscom Air Force Base, Mass., and other sources on known satellites is transmitted to SPADATS.

Here a Philco 2000 EDPS analyzes the data, computes orbits, and catalogs the information. A satellite object board displays the information—the current position of all man-made objects in space.

SPASUR and SPACETRACK receive their data from sensing and tracking devices in various parts of the country and overseas. Both activities have been in operation several years under Navy and Air Force direction, respectively, at the request of the Advanced Research Projects Agency of the Defense Department.

• **More Missile Defense.**—ARPAT (Advanced Research Projects Agency's Terminal) is conceived as follow-on to Nike Zeus, top project in the Defender Program to "stop that missile." ARPAT would be a defense against a wave of ICBM's mixed with decoys.

A carrier would be launched and its flight checked momentarily ahead of the wave while numbers of small homing interceptor missiles would be fired.

The Army Rocket and Guided Missile Agency is managing a development team comprised of Boeing Company, Hughes Aircraft Company, International Business Machines Corporation, and Raytheon Company.

Data on ICBM tracking and reentry are being amassed by the AMERICAN MARINER, a converted Liberty ship that already has measured over forty missile reentries along the Atlantic Missile Range.

The Nuclear Test Ban—A Trap

An Editorial

THE confused thinking so prevalent these days is nowhere more tragic than in the area of the nuclear test ban. For almost three years the United States Government has stopped its tests on the hysterical demand led by motion-picture stars, television personalities, and sections of the American and British press. To date all that we have to show for our pains is lost time.

As has been said so often in these pages, time is one factor in readiness for modern warfare which—once lost—can never be regained. The loss of time in being ready to wage war can be equated directly into loss of American lives and the possible loss of America itself.

So once again it will be worth while to get back to the simplicities as they relate to retaliatory weapons, leaving out of the discussion any unknown researches the scientists in our laboratories have under study.

There are today two general classes of weapons which are of their nature retaliatory. That is to say, the use of such weapons is dependent solely on political considerations. Retaliatory weapons are not used in conventional fighting because, once released, their effects could go far beyond the military target intended by the user.

There is no telling where the damage and even the danger of such use will end; hence, it could extend to friend, foe and, indeed, to one's own forces. Therefore, Country A may use retaliatory weapons only if Country B does. No one, until now, has questioned the right and the duty of both to have such weapons ready for use on the instant.

For years there has been a great hue and cry, inspired by Communist chicanery, against nuclear testing. Our statesmen of the time fell for the propaganda. They walked into a trap from which their successors have been hesitant to extricate themselves—and us. Now there is talk of bringing the matter before the United Nations! This despite the pleas of our own nonpolitical leaders who are well versed in the technology of the subject, such as the Atomic Energy Commission, the Joint Congressional Committee on Atomic Energy, and the Joint Chiefs of Staff.

Dr. Edward Teller leads a long line of accredited scientists who oppose the ban. If our military leaders were permitted to speak, they, too, would plead that we renounce the ban at once.

IF further argument is required, there is the irrefutable parallel in the case of the constant testing of agents for use in possible gas warfare. Certain war gases are retaliatory weapons—once released their control cannot be foretold, and they may reach friend as well as enemy. Decontamination after use in the case of some agents is problematical over long periods of time, thus denying the use of the terrain to victor as well as to vanquished.

But the nations of the world have been testing and developing chemical agents for use in gas warfare for the past forty years. The United States Army has made tremendous strides in the development and testing of gas weapons since World War I. Our armed forces were fully prepared to use such agents in the Second World War. Although the United States Government is not signatory to any international agreement not to use gas in war, gas has not been used in battle by our forces since the First World War. While we may or may not have a sufficient war reserve of chemical weapons, we are prepared to use them, and we continue to develop and test chemical and biological agents.

Such is the inherent nature of retaliatory weapons. It is one thing to test and develop them to the *n*th degree. The decision to use them rests upon the enemy: Use by either side is a political decision whether that use be in the first instance or in retaliation.

Our national survival now depends on some simple stark realities: (1) the capability of using nuclear weapons instantly; (2) world domination by the Communists is a certainty if we do not have this capability.

In this connection we must remember that the major portion of our Defense funds has been devoted to weapons systems with nuclear warheads. Our nuclear capability fully matches that of the Communists.

THE pen of Thomas E. Murray was recently and unfortunately stilled by death. He wrote with crystal clarity and with factual knowledge on this vital topic. A former member of the Atomic Energy Commission, his last testament on this subject appeared in the winter 1961 issue of *Orbis*, quarterly journal of the Foreign Policy Research Institute of the University of Pennsylvania. Mr. Murray wrote:

"An advocacy of the resumption of nuclear tests is by no means synonymous with the wish to see the United States produce weapons more frightful than those which are now in our stockpiles. . . .

"But, although the United States might wisely decide that certain types of weapons should never be developed, it cannot afford to remain blind to the possibilities now available to a power which, according to all past evidence, will not hesitate to exploit them in war or in blackmail. Surely, we cannot develop adequate defenses for the United States in the next decade unless we know all that there is to be known about the performance characteristics of new weapons which may soon be—if they are not already—in the hands of the Soviets. An up-to-date program of active and passive continental defense demands constant technological research—and research requires testing."

By the time this issue of ORDNANCE appears in print, the decision may have been made by the President of the United States to resume nuclear testing. If so, the decision—long overdue—will be a wise one. Even then we will have lost priceless time and will have deprived ourselves of the technical progress that was stopped almost three years ago.

ASSOCIATION AFFAIRS

Wisconsin Post Honors Dr. C. S. Draper And New President At Annual Meeting

The annual meeting of the Wisconsin Post was held at the Falk Corporation in Milwaukee on May 22nd followed by a banquet at the Wisconsin Club. There was a capacity crowd to honor one of the Nation's leading space scientists, Dr. C. Stark Draper, and to meet the Post's new president-elect, Alvin B. Goodspeed, former Post secretary.

Dr. Charles S. Draper, director of the M.I.T. Aeronautics and Astronautics Department, left, guest speaker at the Wisconsin Post meeting, chats with Post President Algie A. Hendrix and Richard S. Falk, banquet chairman, right.

Mr. Goodspeed succeeded Algie A. Hendrix who held the office for the past three years. It was during his terms of office and under his leadership that the efforts to arouse membership participation and interest in Post activities was started. In that period members have heard talks from some of the country's top military and industrial leaders.

Credit for the excellent turnout was shared with Richard Falk, assistant to the president, Falk Corporation, who, for the second year, served as general chairman for the black-tie affair.

In his "farewell address" as Post president, Mr. Hendrix noted the United States "no longer can enjoy the luxury of getting ready a year or two after a threat to our national security occurs." He said that with the period between survival and annihilation being measured in minutes, "it is what we are doing in industry now to provide the deterrents that will make any potential aggressor stop and think twice before he pushes any buttons."

He added that the progress of America was founded on the successful teamwork between private enterprise and the Government, "each respecting the position of the other." Mr. Hendrix called on the members to continue to stimulate this harmonious concept "to our employees, our men in government, and to the future leaders of our country."

Highlighting the evening session was the address by Dr. Draper, Director of the Aeronautics and Astronautics Department and head of the Instrumentation Laboratory at Massachusetts Institute of Technology.

Dr. Draper, who developed the guidance system concepts for the Thor, Titan, and Polaris ballistic missiles, told the A.O.A. members and guests that the space flight of Comdr. Alan Shepard proved that man can survive the pressures of launching and return, and in a weightless condition still sense, think, communicate, exercise judgment, and carry out decisions.

He added that progress in this area would cost billions of dollars and that since the United States was "in the space game" the American people will have to build up more knowledge to weigh the answers to such questions as the military usefulness of men in space.

Other Post officers elected were Robert C. Uihlein, Jr., vice-president, and Robert C. Pratt, secretary-treasurer. Mr. Uihlein is president of the Joseph Schlitz Brewing Company, and Mr. Pratt is president of the Pratt Manufacturing Corporation.

West Point Buildings Memorialize Names Of Three Army Ordnance Stalwarts

Three great names in Army Ordnance were permanently memorialized at West Point when three historic buildings, Benton, Benét, and Crozier Halls, were dedicated in ceremonies on May 25, 1961. The officers honored were: Capt. James G. Benton, Class of 1842, the first instructor and head of the then Department of Ordnance and Science of Gunnery at the Academy.

Maj. Gen. Stephen V. Benét, Class of 1847, the second head of the department. He later served seventeen years as Chief of Army Ordnance.

Maj. Gen. William Crozier, Class of 1876, who was a mathematics instructor at West Point and later became Chief of Army Ordnance, also holding the position for seventeen years.

The old halls have been converted into activity centers for first classmen (seniors) and their guests.

Situated close to scenic Trophy Point, the structures built in 1837 provide a physical link with the heritage of West Point's past.

The buildings, previously unnamed, are part of what is known as the Ordnance Compound, which for ninety years was used for instruction and housing by the academy's Department of Ordnance. The compound lies west of Trophy Point where the hill begins its descent to the Hudson River.

During their first twenty years the buildings housed the then Department of Artillery. When the Department of Ordnance was founded in 1857, they were used for instruction buildings by that department.

Then, from 1913 to 1947 they were used

as living quarters for members of the Ordnance detachment. In 1947 they became apartments for noncommissioned officers.

The sponsors for the memorial plaques displayed on the buildings were: Maj. Gen. W. C. Westmoreland, Superintendent, U.S.M.A., for Captain Benton; Lieut. Gen. J. H. Hinrichs, Chief of Army Ordnance, for General Benét; and Brig. Gen. Earl McFarland, U.S.A. (Ret.), for General Crozier.

General McFarland was accompanied at the ceremony by Mrs. James L. Walsh, widow of Colonel Walsh, president of the A.O.A. from 1947 to 1952.

A.O.A. Artillery Division Inspects Ground Support Equipment At White Sands

The ground support equipment of the "glamorous" guided missiles and rocket systems at White Sands Missile Range, N. Mex., had its day on May 25th when it was the focus of attention of the visiting Artillery Division

Meeting at the call of Chairman Joseph L. Auer, R. Hoe & Co., New York, N. Y., the conferees were welcomed by Lieut. Col. F. P. Dyhrmann, acting for Maj. Gen. J. G. Shinkle who was away from the Missile Range at that time. The Division was briefed on the mission and activities of WSMR and then immediately began a tour of some of the facilities. The morning was spent inspecting ground installations and observing a missile launching.

Following lunch, several missile systems were described and equipment therefor was demonstrated and inspected. After observing another launching, the Division heard two technical papers. Lewis L. Gober, Army Ballistic Missile Agency, Redstone Arsenal, Ala., discussed "Ground Support Equipment—Concepts and Design." Roy Pugh, Army Rocket and Guided Missile Agency, also of Redstone Arsenal, then presented "Trends in the Ground Support Equipment Area."

The full day was climaxed by a dinner and an address by Col. J. J. O'Connor, WSMR, whose talk, "Testing Artillery Missile Systems at WSMR," was complemented by a movie on the subject.

Capt. H. F. Hardin, Jr. Receives Alden Award At Ordnance School Graduation

Capt. Harold F. Hardin, Jr., received the Association's Alden Award at graduation exercises of the U. S. Army Ordnance School, Aberdeen Proving Ground, Md., on June 23rd. He was graduated from the Ordnance Officer Career Course and was cited as the outstanding student of the class.

The Alden Award, a check for $100, is presented by the American Ordnance Association annually in memory of the late Col. Herbert W. Alden, a founder of the Association and for many years one of its most active officers. He was chief engineer of the Timken-Detroit Axle Company and also chairman of the Ordnance Automotive Advisory Committee of the Society of Automotive Engineers during the years between the First and Second World Wars. He died November 11, 1950. The fund which provides the annual award was given to the Association by the company in tribute to his outstanding work both as an automotive engineer and as a Reserve officer of Army Ordnance, and also for his loyalty to the Association.

Maj. Gen. Dwight E. Beach, Deputy Chief of Army Research and Development, presented 107 diplomas and addressed the graduates. A portion of his remarks is published on page 203 of this issue.

General Beach was introduced by Col. H. A. Snyder, Commandant of the School. The master of ceremonies at the exercises was Maj. Arunah Strassberger, secretary of the School. The Alden Award was presented by Leo A. Codd, executive vice-president of the Association.

Capt. W. C. Hushing Describes Polaris System At Capital Cities Post Dinner

Highlight of the final dinner meeting of the 1960-1961 season conducted by the Capital Cities Post on June 27th, was a progress report on the Polaris missile system presented by Capt. William C. Hushing, U.S.N., superintendent of ships, Electric Boat Division, General Dynamics Corporation, Groton, Conn.

Captain Hushing described the rapid steps in engineering development that enabled the Navy to telescope nuclear submarine development so that some classes of submarines were converted to a later class before they were completed. This phase of progress also helped to expedite Polaris submarine construction.

The captain also described some of the many devices that enabled the Navy to simulate shipboard operation of the missile before a submarine was completed. His presentation made it apparent how it has been possible to reduce the date of operational readiness for fleet ballistic missile submarines.

Some 130 members and guests gathered at Crooked Lake Hotel, Crooked Lake, N. Y., for the dinner and installation of newly elected Post officers headed by Peyton Townes, manager of integration engineering for the Polaris system at the General Electric Company plant, Pittsfield, Mass. As Post president for the coming year, Mr. Townes succeeds William Stuart who is a civilian executive assistant at Watervliet Arsenal, Watervliet, N. Y.

Other officers named for 1961-1962 include: Col. Walter M. Tisdale, Watervliet Arsenal commanding officer, first vice-president; Kenneth Hamilton, Argus-Greenwood, Inc., Albany, N. Y., second vice-president; John E. Benson, Jr., Watervliet Arsenal, secretary-treasurer; and Rear Adm. Wilson D. Leggett,

Capt. William C. Hushing, U.S.N., center, was the guest speaker at the final season meeting of the Capital Cities Post. At left is William Stuart, outgoing Post president, who was succeeded by Peyton Townes, new president, right.

U.S.N. (Ret.), Alco Products, Inc., Schenectady, N. Y., national Council representative.

Named to the Post board of directors for 3-year terms were: Colonel Tisdale; Richard Arthur, General Electric Company, Schenectady; Edward O. Greeson, Watervliet Arsenal; and Prof. A. A. K. Booth, Rensselaer Polytechnic Institute, Troy, N. Y.

A.O.A. Bomb And Warhead Group Holds Annual Meeting At Picatinny Arsenal

More than 150 members, consultants, and guests of the Bomb and Warhead Assembly Section, Bomb, Warhead and Artillery Ammunition Division, converged on Picatinny Arsenal, N. J., on May 4th to attend the Section's annual meeting. Brig. Gen. M. H. Davis, U.S.A. (Ret.), chairman of the Section, led the meeting which reviewed papers on current warhead activities and problems.

At Bomb and Warhead group meeting are, left to right: Maj. Gen. E. P. Mechling, A.O.A. staff; Col. Henry N. Marsh, A.O.A. vice-president for technical operations; Col. S. R. Stribling, World War II bomb expert; J. H. Robinson, Picatinny Arsenal; Brig. Gen. M. H. Davis, Section chairman; and Maj. Gen. W. K. Ghormley, Commanding General of the Ordnance Special Weapons-Ammunition Command.

The topics ranged from cluster-type warheads to warheads for the Redeye, Shillelagh, GAM-83, and Bullpup B. Others discussed the fabrication of the Little John warhead skin, Navy modernization and supporting research programs, fragmentation warheads in space, nonexplosive warheads, and new high-strength steels.

Picatinny Arsenal papers were presented by C. Kobialka, S. Lerner, J. Finn, and C. Zglenicki. Naval Ordnance Test Station, China Lake, Calif., was represented by R. G. S. Sewell and Roy Compton, while F. R. McCleskey spoke for the Naval Research Laboratory, Dahlgren, Va., and Dale Davis for the Eglin Air Force Base, Fla.

Industrial speakers included W. R. Porter, Martin Company, Orlando, Fla.; D. Kennedy, Aerojet-General Corporation, Downey, Calif.; and R. P. Sernka, Aeronutronic Division, Ford Motor Company, Newport Beach, Calif.

On May 5th the Section visited several arsenal facilities to observe tests and demonstrations, the tour being interrupted briefly as members paused to listen to the broadcast of the epochal space flight of Comdr. Alan G. Shepard, Jr., from Cape Canaveral, traveling down range and landing in the Atlantic ocean.

Texas Post Members Combine Elections, Yacht Ride, Dinner, And "Space Trip"

Texas Post officers for the 1961-1962 term were installed on July 7th at a meeting of 70 members and guests who met late in the afternoon at the Port Houston Turn Basin where they boarded the luxurious 95-foot yacht, SAM HOUSTON, for a 15-mile cruise down the highly industrialized Houston ship channel.

After the 90-minute trip, they disembarked at the world famous San Jacinto battlegrounds where they enjoyed a sumptuous sea food dinner at the San Jacinto Inn and the new officers and directors were formally introduced.

F. G. Huber, immediate past president, was presented with a certificate of appreciation by Post President H. A. Helms, Baash-Ross Division, Joy Manufacturing Company, the presiding officer.

The speaker of the evening was the new vice-president, Larry Megow of Hahn and Clay. His pictorially illustrated talk, "Landing on the Moon," was a follow-up on President Kennedy's State of the Union message in which the President requested Congress to appropriate $7 billion for the development of a moon rocket.

The informal meeting was successfully concluded when every one boarded air-conditioned buses for a leisurely ride back to Port Houston.

The newly elected officers of the Post, in addition to Mr. Helms, and Mr. Megow, are: secretary-treasurer, H. C. Hill, Hughes Tool Company; and the following directors; George Lenard, Cameron Iron Works; L. V. Dolan, Dolan Industrial Sales; A. D. Blackledge, Cameron Iron Works; P. M. Pappas, Super Chef Manufacturing Company; J. D. Mamarchev, consulting engineer; and H. H. Olson, Sheffield Steel Company.

Military Specifications Are Studied At Meeting Of A.O.A. Documentation Group

Military standards and specifications pertaining to engineering documents were the subject of study, discussion, and comment by the Steering Committee, Engineering Documentation Section, Production Techniques Division, at its Washington, D. C., meeting of May 23rd and 24th.

Chairman W. W. Thomas, Radio Corporation of America, Moorestown, N. J., opened the meeting with a report of the meeting of the Special Committee on Technical Publications which he attended on April 26th. After reviewing the meeting detail he noted that a joint meeting was arranged, to be held in Washington, D. C. On September 12th, the Steering Committee, Engineering Documentation Section, will meet, and on September 13th, that Committee will hold a joint meeting with the Steering Committee, Special Committee on Technical Publications. On September 14th, the latter Steering Committee will hold its individual meeting.

The Committee then moved to the consideration of Specification Mil-D-70327-A. Problems already encountered were dis-

cussed as were the adequacy of the specification for vendor requirements, its capability of meeting specific service and corps needs, its capability as a procurement specification, and its ability to absorb other specifications. Mil-Std-1-B and its relationship to the drawing standard Mil-Std-8 also were discussed.

Configuration control was scrutinized in detail, and a subcommittee was established to recommend improvements to the current status. In addition, several other subjects subsidiary to major problem areas were considered briefly but were held over for later Committee action when they can be considered in greater detail.

The Committee concluded its meeting by confirming the dates of September 12th and 13th for its next session in Washington, D. C.

Birmingham Post Marks Armed Forces Day With Meeting At Redstone Arsenal

Approximately 250 members and guests of the Birmingham Post of the American Ordnance Association visited Redstone Arsenal on Armed Forces Day and held their annual spring luncheon in the Redstone Officers' Mess. Maj. Gen. John A. Barclay, Jr., Deputy Commander of the Army Ordnance Missile Command, was the guest speaker.

Col. Russell B. Sell, Commanding Officer of the Birmingham Ordnance District and secretary of the local Post, presided at the luncheon. Colonel Sell expressed his appreciation to the Redstone Arsenal personnel for their hospitality in arranging the transportation and the luncheon facilities.

General Barclay welcomed the members and guests to the arsenal on behalf of the Commanding General, Maj. Gen. August Schomburg. He gave an outline of the mission and facilities of the Army Ordnance Missile Command, Redstone Arsenal, and the George C. Marshall Space Flight Center. General Barclay stated: "I am delighted to have open house and show some of the things which are at the Army Missile Development Center. The real purpose of our work here is to provide the best weapons system to the troops for their use as needed.

"The Zeus is the Number One missile at this time," General Barclay said. "Nike Zeus is the antimissile missile system which the Army feels can do all that is expected of it—and more. A defending missile can be directed on a path which will cause it to intercept an incoming missile. Nike Zeus is the only weapon system under development to neutralize the supreme challenge of the long-range ballistic missile. Army Ordnance is confident that it can do the job of defending our population centers in the event of a missile attack."

He added that an Army-Industry scientific team had successfully advanced the antimissile missile concept to the research and development matériel stage.

Following luncheon, the A.O.A. members and guests were given a guided tour through the facility, visiting the Armed Forces Day display and various demonstrations. The tour was highlighted by a visit to the Saturn assembly area at the George C. Marshall Space Flight Center where members were given a detailed briefing and close-up view of the impressive rocket. The Saturn will be used for the exploration of space in the coming years.

The members also viewed firing demonstrations of the SS-10, a rocket-propelled tank killer that actually can be steered through the air to its target by a soldier operator. The newly developed M72, a light antitank weapon, was fired for public viewing for the first time.

The new weapon, essentially a potent but small rocket packed in a lightweight carrying case that also serves as its launcher, is effective against tanks and armored vehicles as well as a variety of battlefield fortifications, such as pillboxes. The rocket and launcher combination weighs about four pounds and can be carried slung over the shoulder like a quiver of arrows. It snaps open and can be ready to fire in a matter of seconds.

The members also viewed a static test and propulsion test firing conducted by personnel of the Army Rocket and Guided Missile Agency.

This highly interesting and informative field trip by outstanding leaders of industry of the Birmingham Post was arranged by Ordnance personnel located at the Birmingham Ordnance District and Redstone Arsenal, Ala. It is indicative of the fine cooperative spirit existing between the Ordnance-Industry Team in this area.

Attending Birmingham Post meeting at Redstone Arsenal, Ala., are, left to right: F. H. Coupland, K. R. Daniels, and S. D. Moxley, all of the American Cast Iron Pipe Company, Birmingham, Ala.; and Col. R. B. Sell, Commanding Officer of the Birmingham Ordnance District. More than 250 members attended to celebrate Armed Forces Day, hold their annual spring luncheon, and inspect new weapons.

Philadelphia Post Sails To Fairless Steel Plant For Thirty-fifth Annual Meeting

It was "anchors aweigh" for the Philadelphia Post on board the steamer, SEA BELLE, for the group's thirty-fifth annual meeting on Friday, June 30th.

Over 400 members manned the rails as the SEA BELLE got under way from the Chestnut Street dock in Philadelphia and headed up the Delaware River for the Fairless Steel Plant of the U. S. Steel Corporation. All hands relaxed in the sun watching the passing panorama of industrial centers, interspersed with pleasant residential areas and farm lands.

En route to the Fairless Works, a brief business session was conducted by Post president George Burnham, IV, who received the reports of the Post secretary-treasurer, William F. Rathgeber, Jr., and instructed the members on the plans for the tour of the steel mill. The meeting was followed by an excellent buffet luncheon, completed as the steamer docked about noon at the Fairless loading wharf.

The members were taken by bus on a complete tour of the vast area of the largest integrated steel plant in the United

States and at several key spots left the buses to observe steel pouring and fabricating operations at close hand.

From the buses operation of the coke ovens and blast furnaces was observed, and the members walked through the open-hearth furnaces, the automated strip mill, the department where sheet is coiled for shipment, and the newly installed continuous-process cold-reduction mill.

It was an interesting but strenuous afternoon that made the refreshments aboard SEA BELLE especially welcome on the return voyage.

General Schomburg Addresses Aberdeen Post At Annual Meeting In Baltimore

The gala dinner meeting of the Aberdeen Post held annually in Baltimore was convened this year on May 24th to honor Maj. Gen. August Schomburg, Commanding General of the Army Ordnance Missile Command. The reception and dinner were held in the Southern Hotel with over 300 members in attendance.

Maj. Gen. August Schomburg, Commanding General, Army Ordnance Missile Command, second from right, was guest speaker at Aberdeen Post annual meeting. With him are Brig. Gen. J. H. Weber, Commanding General of Aberdeen Proving Ground, left; C. D. Nitchie, past Post president; and W. H. Ramsey, newly elected president, right. The meeting was held at the Southern Hotel, Baltimore, Md.

General Schomburg, in addressing the gathering, outlined the Army missile program, its origination, and present and future developments. The General also demonstrated several new experimental devices that are representative of some of the exciting results of research at A.O.M.C. These included microminiaturized radio transmitters and oscillators and a precision heat-seeking, infrared-detecting instrument. He also demonstrated how fluids can be employed in guidance and control circuits in place of electronic circuits.

Throughout his presentation General Schomburg stressed the need for ruggedness and simplicity in all missile components and assemblies. In conclusion he presented an excellent film on missiles in action, including recent shots of Nike Zeus.

The presiding officer, Post President Charles D. Nitchie, called on Col. Leo A. Codd, executive vice-president of the A.O.A. to introduce the guest of honor.

In preliminary business the new officers and directors for 1961-1962 were introduced. They are: president, Walter H. Ramsey, chief of operations, Development and Proof Services, Aberdeen Proving Ground; vice-presidents, Richard Sanford, manager, Space Programs Office, Air Arm, Westinghouse Electric Corporation, and Gerald W. Hayes, chief, Plans Office, Aberdeen Proving Ground; secretary-treasurer, E. B. Cummins.

The newly elected directors are: Col. R. R. Entwhistle, Director, Ballistic Research Laboratories; Wadsworth Sadlowski, Development and Proof Services, Aberdeen Proving Ground; E. C. Schroder, Jr., Ordnance Training Command, Aberdeen Proving Ground; O. W. Carman, Koppers Company; Robert E. Kirby, Westinghouse Corporation; and Richard S. Dowd, Aircraft Armaments, Inc.

Science Students Honored At Meeting Of Yankee Post, Watertown Arsenal

At its spring meeting, sponsored by the Watertown Arsenal, Watertown, Mass., the Yankee Post was host to one hundred distinguished science students and Science Fair winners from New England including thirty Greater Boston high schools. The program opened with a tour of the arsenal's high-temperature laboratories and the United States Army's first and only nuclear research reactor. The tour was preceded by a welcome from Col. R. B. Braid, commanding officer of the arsenal.

Following the tour a reception was held in the arsenal's open mess followed by a dinner meeting at which the guest speaker was Maj. Gen. John A. Barclay, Deputy Commanding General, Army Ordnance Missile Command, Huntsville, Ala.

Post President John Gannett thanked Colonel Braid for his hospitality and welcomed the members and student guests.

General Barclay directed his remarks to the science students and gave them an excellent concept of the achievements of Army Ordnance and the great opportunities it offers those with engineering or scientific ability. He noted that the vast Ordnance establishment that ships out millions of tons of equipment and expends over $3 billion yearly has a great need for energetic and knowledgeable young men.

As an example of the complexity of modern ordnance and the need for technical skill, General Barclay outlined the basic problems that had to be solved in developing the Nike Zeus antimissile missile. He also mentioned several products of Army ordnance research and development that have contributed to improved industrial processes such as ceramic-tipped cutting tools and a device that measures liquid flow by means of sound waves. In his conclusion General Barclay said:

"We are living in a great hour, one of the most challenging that Americans have experienced. The brightest pages of our Nation's history are still unwritten—of this I am sure. What the hand of time will eventually inscribe on these pages will depend in large measure upon the determination, the vigor, and the devotion that each of us brings to the tasks that lie ahead."

The Yankee Post was acclaimed by many New England civic leaders and organizations for its practical approach in arousing the interest of high-school science students in the national defense.

Test Range Instrumentation Section Probes Problems At Meeting In California

Test-range instruments and control systems continue to present development problems as more severe requirements are placed upon them. Some ten of these problems were defined and presented to panels of the Test Range Instrumentation Section, Missiles and Astronautics Division,

at its meeting April 11th and 12th at the Salton Sea Test Range of the Sandia Corporation in California.

Led by the Section chairman, Dr. C. W. Miller, Aerospace Corporation, El Segundo, Calif., twenty-one Section members and guests heard the problems submitted by a team from the Sandia Corporation, Albuquerque, N. Mex. Team members were T. V. Crawley, H. V. Fisher, A. F. Huters, K. L. Kemp, D. Parsons, W. M. Ray, and J. B. Wade.

The Section was first oriented on the mission of the Salton Sea Test Range. Projects and problems were then presented by the Sandia team, after which the Section members inspected the range facilities. The panels then reconvened to consider the problems, including such subjects as tracking control systems, drive systems for tracking devices, high-speed large camera construction, large telescope design and engineering, millisecond photographic controls, and others. Also noted was the regular problem of inadequate timely funding for test-range instrumentation.

Following discussion periods, the panels prepared their summaries and presented them to the Section as a whole for appropriate action.

General Zierdt Tells Of Antimissile Defenses At Volunteer Post Meeting

Brig. Gen. John G. Zierdt, Commanding General, Army Rocket and Guided Missile Agency, Huntsville, Ala., was guest of honor at the Volunteer Post annual meeting, Belle Meade Country Club, Nashville, Tenn., on June 7th.

General Zierdt, who has directed the Nike Zeus antimissile program since early 1960, held the attention of his audience with his crisp presentation of the requirement, development, and components of the Nike Zeus systems. He made it clear, using activated slides, that the major items and the expensive ones in the system were the radars and computers. The missile itself, the expendable part, although of advanced design, was a small part of the system's costliness.

Explaining that "it is our goal to provide the Nation with an antimissile defense system that will not only meet the threat of today but the need of tomorrow," he announced that a new project had been started to produce a "more advanced" radar to permit tracking at ranges beyond our shores.

Brig. Gen. H. A. Nisley, Post president, on behalf of Nashville's Mayor, Ben West, presented an honorary citizenship scroll and key to the City of Nashville to General Zierdt upon the conclusion of his talk.

General Nisley then introduced the incoming Post president, Neil H. Cargile, vice-president, Allan Products Inc., Nashville, who in turn announced the following new officers and directors who will serve for the coming year:

Vice-presidents: Wesley H. Dyer, Metal Products Company; Edwin A. Keeble, Edwin A. Keeble and Associates; Bernard A. McDermott, Ferro Corporation; secretary-treasurer, Dempsey Weaver, Jr., Turner & Weaver Insurance Company; and the following directors: Frank Englert, Jr., Englert Engineering Company; Capt. Harold A. Wells, professor of naval science and tactics, Vanderbilt University; L. A. Tanksley, Temco, Inc.; and national Council representative, Granville B. Bourne, Third National Bank, Nashville, Tenn.

A rising vote of acclaim was accorded General Nisley for his great leadership as Post president during the past two years.

In preliminary events, General Niseley introduced the other guests at the speakers' table who were: Mr. Bourne, Captain Wells, Mr. Weaver, and Rev. Douglas J. Berndt, assistant rector, St. George's Episcopal Church who delivered the invocation and closed the meeting with a benediction.

Technical Papers Feature Meeting Of Loading Section At Joliet Arsenal

Representatives of thirteen industrial firms and fourteen Government installations met at Joliet Arsenal, Ill., for the annual meeting of the Loading Section, Bomb, Warhead and Artillery Ammunition Division. Fifty-two members, consultants, and guests met May 23rd at the call of the chairman, Brig. Gen. Joel G. Holmes, U.S.A. (Ret.), Mason & Hanger-Silas Mason Company, Iowa Ordnance Plant, Burlington, Iowa.

Brig. Gen. R. M. Hurst, Commanding General, Army Ballistic Missile Agency, Redstone Arsenal, Ala., was the guest speaker at dinner. He reviewed the Army's missile programs and discussed some recent changes in management as well as some aspects of various weapons systems.

Dr. Herbert Ellern, Universal Match Corporation, Ferguson, Mo., spoke briefly at the meeting. Dr. Ellern is the new chairman of the Bomb, Warhead and Artillery Ammunition Division, having recently succeeded Robert L. Telford, Mason & Hanger-Silas Mason Company, New York, N. Y., who is now chairman emeritus.

Nineteen technical papers were presented during the 2-day meeting. Subjects covered included factors affecting research and design of ammunition, testing and test equipment, production techniques generally and specifically for some items of ammunition, ammunition renovation, and safety methods. Other papers covered the trends of fuzes, solid rocket propellants, tank ammunition, extended-range ammunition, and recoilless-rifle ammunition. Safety was discussed in a separate paper as well as constituting an important part of almost all other papers.

Members and consultants of the Loading Section, A.O.A. Bomb, Warhead and Artillery Ammunition Division, attending annual meeting at Joliet Arsenal, Ill.

Surface Preservation Section Holds Annual Meeting At Frankford Arsenal

Gold, tin, chromium, and other metals were among the subjects of papers presented to the members of the Surface Preservation Section, Production Techniques Division, at its twenty-ninth meeting on May 10th at Frankford Arsenal, Philadelphia, Pa.

Chairman M. B. Diggin, Hanson-Van

Lieut. Gen. Blackshear M. Bryan, left, New York Post president, presents the A.O.A. Col. James L. Walsh Memorial Award, a sporting rifle, to Cadet P. G. Dombrowski for excellence in ordnance engineering at West Point.

At the Air Force Academy Col. James Colasanti, Rocky Mountain Post president, presents A.O.A. Dr. Robert H. Goddard Memorial Award, a sporting rifle, to Cadet Maj. Oleg R. Komarnitsky for proficiency in mathematics.

At the Naval Academy Rear Adm. M. F. Schoeffel, deputy chairman, Missiles & Astronautics Division, presents the Association's Adm. W. H. P. Blandy Memorial Award, an engraved shotgun, to Midshipman M. D. Bickel for weapons proficiency.

Winkle-Munning Company, Matawan, N. J., led the forty-nine members, consultants, and guests who heard the papers and reports. A. Gallaccio, Frankford Arsenal, presented the first technical paper on "Practice Recommended in Preventing Corrosion between Dissimilar Metal Couples." L. O. Gilbert, Rock Island Arsenal, Ill., then discussed "Recent Advances Made in Ordnance Corps Matériel through Surface Preservation."

The third paper, by C. F. Nixon, Research Laboratories, GMC, Warren, Mich., was on "Accelerated Testing—Some Recent Advances in Modified Salt Fog Corrosion Test Methods." P. C. Rech, Pennsalt Chemicals Corporation, Philadelphia, Pa., spoke on "Chromium-Containing Protective Coatings."

"The Role of Precious Metal Plating in the Defense Industry," was described by E. C. Rinker, Sel-Rex Corporation, Nutley, N. J. The final paper, "A Progress Report on the Stannate Process for Magnesium," was given by H. L. Ammlung, Aberdeen Proving Ground, Md.

Committee reports were received from Dr. J. A. Stevens, Dow Metal Products Company, Midland, Mich., on light metals and alloys; E. A. Stockbower, Amchem Products, Inc., Ambler, Pa., on phosphate and conversion coatings; C. H. Sample, International Nickel Company, New York, N. Y., on electrodeposited coatings; and R. T. Gabbert, Sherwin-Williams Company, Chicago, Ill., on organic coatings.

A concluding feature was an animated film, "Corrosion in Action," shown through the courtesy of the International Nickel Company.

The Section proposes to hold its next meeting on October 24th and 25th at Redstone Arsenal, Ala., if arrangements can be made.

on the future plans of the Post, including an invitation to more leaders from industry to make presentations to the Post. He also discussed the possibilities of having a future placement branch supported by the A.O.A. national headquarters within the Post.

This year the activities of the group have included trips to the Charleston Air Force Base, U. S. Naval Base, Aberdeen Proving Ground, and Washington, D. C. The Post also featured ordnance displays on the campus at various times during the year. In addition the Post held monthly meetings with guest speakers representing such military establishments as the Polaris Missile Base, Cape Canaveral, Fort Sumter, and the Air Defense Command.

Projects during the year included a

(Continued on p. 237)

Citadel Post Marks Change Of Officers During Annual Banquet At Charleston

The American Ordnance Association's Citadel Post climaxed the most active year in its history at a formal banquet held in Mark Clark Hall, Charleston, S. C., on May 9th. Leadership shifted as Cadet Lieut. Col. Samuel R. Bird, Post president for 1960-1961, turned over the gavel to Cadet William M. Fambrough, Jr., who will preside during 1961-1962.

Highlighting the banquet was the presentation of a Post resolution to Lieut. Col. Thomas N. Courvoisie who had been faculty adviser to the Post for two years. He has relinquished his affiliation with the Post because of the press of his new duties as assistant commandant of cadets. The formal resolution cited Colonel Courvoisie for his "interest and devotion and untiring performance of duty."

Following the presentation, Cadet Bird spoke to the members about the proud record the Post had made during the year. The organization has been cited on numerous occasions by national A.O.A. headquarters as being one of the top Posts among the entire organization of over 40,000 members.

Cadet Fambrough projected his ideas

Gen. Mark W. Clark, Superintendent of the Citadel, right, presents A.O.A. plaque and certificate to Cadet Lieut. Col. S. R. Bird, Post president, for outstanding service to the Citadel Post during 1960-1961.

Environmental and secondary power systems for multiman spacecraft...

1. Main cabin environmental control system . . . cryogenic atmosphere supply, cooling system, pressurization and constituent controls, water purification.

2. Re-entry/emergency environmental control system.

3. "Back pack" breathing and pressurization system.

4. Secondary power system . . . multiple re-entry turbine, pump, alternator and cryogenic fuel supplies.

5. Attitude control system . . . reaction motor, fuel and attitude controls.

6. Instrumentation . . . flight data and physiological monitoring systems.

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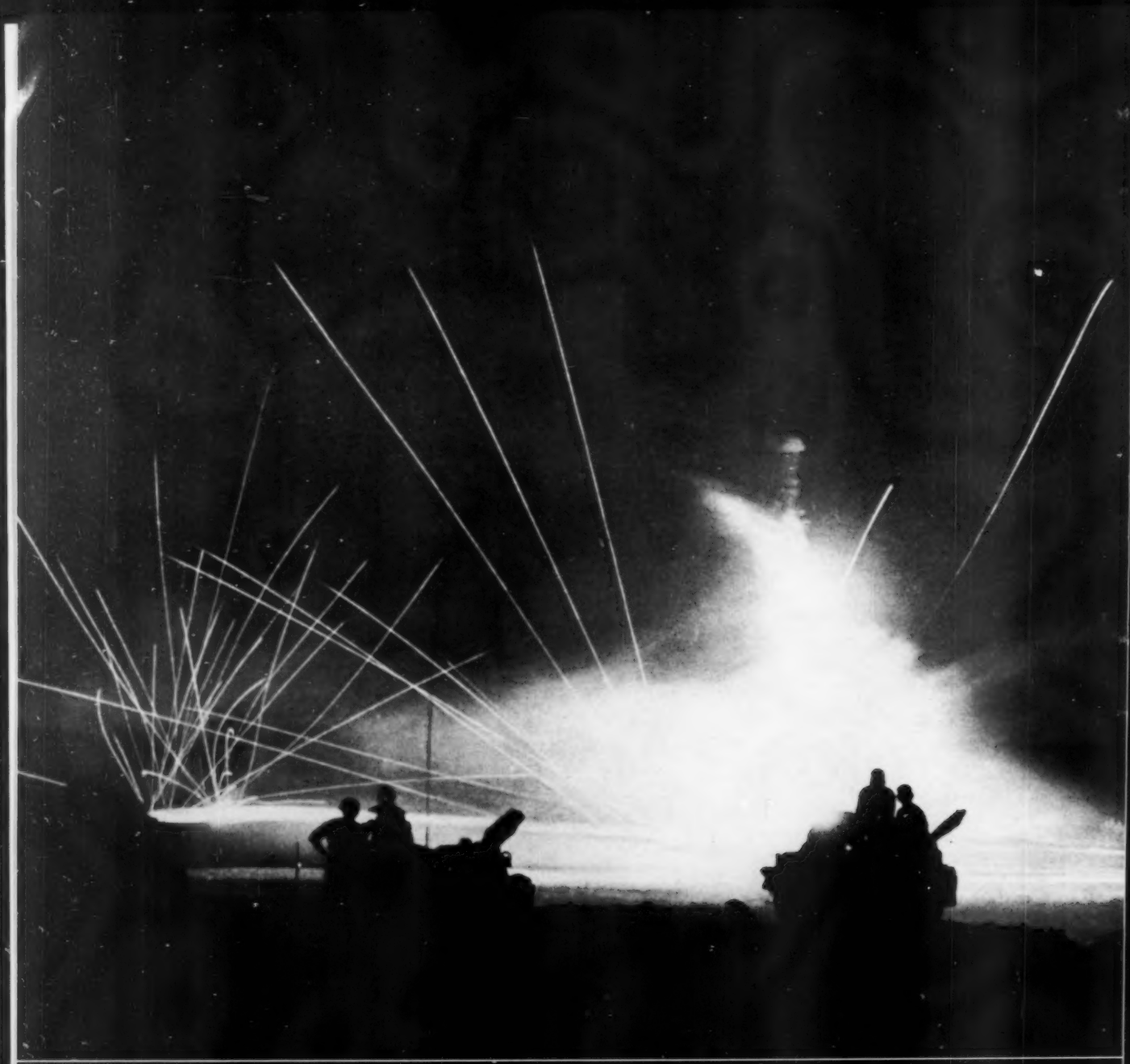

Armor it...

lighten it...

speed it...

ALCOA ALUMINUM BOOSTS FIREPOWER MOBILITY

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Official U.S. Army Photograph

study of Civil War ordnance, the Army's latest small arms, and the most recent developments on land, on and under the sea, in air, and in space.

In addition to Post President Fambrough, other 1961-1962 officers are: Cadet Jerry H. Crunkelton, vice-president; Cadet Hugh Z. Graham, secretary; Cadet Lamar B. Logan, treasurer; and Cadet Tom L. Brown, registrar.

The officer of registrar is newly created, and this officer will be in charge of membership, which it is hoped will increase appreciably during the coming year.

During the awards ceremony the superintendent of the Citadel, Gen. Mark Clark, presented to Cadet Bird the A.O.A.'s certificate of appreciation and the A.O.A. plaque inscribed, "For Outstanding Service to the Citadel Post, 1960-1961."

Dixie Post Members Attend "Project Mobility" At Forts Eustis And Story

Dixie Post members were included among the guests at the U. S. Army Transportation Corps exercise "Project Mobility" held at Fort Eustis and Fort Story, Va., on June 5th.

In the morning, port terminal, rail, and highway operations were demonstrated as related to the transporting of supplies, equipment, and personnel. Various types of lifts from ship booms to traveling cranes were shown and specially designed trucks, cabs, trailers, and containers were used.

The use of helicopters for transporting troops and supplies was demonstrated, and the various types of planes used for reconnaissance, transporting cargo, troops, and equipment were observed in action in support of a mock troop attack. The transport planes, designed for landing and taking off in a minimum distance, could be maneuvered in a relatively short ground area and were constructed for ease of loading and unloading a maximum payload.

Some specially interesting items were:

An experimental lift truck that could be moved and operated by a man standing or walking alongside it.

An automobile with retractable front and rear wheels to ride on rails.

A man moving a ground-effect platform on which rested a cargo packet; the vehicle or platform was cushioned by air at ten pounds per square inch pressure.

A 69-foot Redstone missile and its transporting equipment.

Beach operations were observed in the afternoon at Fort Story. Terminal operations particularly adaptable to limited and nuclear warfare necessitate the use of numerous small ports, centrally controlled, where cargo, personnel, and equipment can be moved through and over beaches. In these operations, jeeps, tanks, bulldozers, trucks, and artillery, were unloaded from landing craft and amphibious vehicles. The M113 aluminum armored personnel carrier transported combat personnel to the beach from an LCM.

The unloading of cargo by helicopters from a moving Liberty-type ship, having an extended deck on one side, was demonstrated, and three cargo packets were removed from the ship while it was approaching shore at full speed. The rescue of an Army swimmer by helicopter also was shown.

The most dramatic part of the Transportation Corps presentation was made after dark, when several hundred troops, armored personnel carriers, trucks, and auxiliary equipment were unloaded in a night beach landing operation. These operations were carried out completely in the dark by means of infrared beams and detectors.

Since this was a mock combat operation to recapture territory previously lost to the enemy, the first to embark were divers, who surveyed the beach terrain. They were followed by landing parties in rubber boats, which in turn were followed by amphibious craft consisting of Dukws, Barcs, and Larcs. Trucks, APC's, and other equipment were landed from LCM's.

Television screens were set up in front of the grandstand and showed a normal television picture of the operations being performed in the dark by means of amplification of the normal moonlight or starlight present at night.

Ten helicopters landed on a sand air strip surfaced with steel landing mats to demonstrate the means of supplying forward moving troops. This was done without lights other than six hooded markers on the landing strip.

Three complete companies of several hundred personnel with auxiliary equipment were landed in the dark in a total of twenty-nine minutes, and the final demonstration was a parade of all personnel and equipment before the grandstand.

Standards And Metrology Division Holds Annual Meeting At Albuquerque

One hundred and sixty-two members and guests of the Standards and Metrology Division met in Albuquerque, N. Mex., at the call of Chairman C. Thorpe Thomp-

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Think of the military concept, "Strategic, combat-ready, mobile forces," and you're thinking *aluminum.*

Aluminum can lop off the necessary pounds in a tank or personnel carrier to make them air-transportable . . . even air-dropable. At the same time, it can provide ballistic protection that's superior to other armor materials. The vehicle can travel faster or farther on its fuel. More, armor alloys continue to perform effectively at elevated temperatures as well as extremely low temperatures. Unlike most metals, aluminum maintains or even improves its toughness at cryogenic temperatures.

Aluminum has done all this. It can do more. No other metal combines all these abilities: mobility, armorability, flexibility, air transportability, air dropability, field weldability, designability and availability. And no other company knows so much about aluminum as Alcoa.

Alcoa—owner of the largest and most extensive R&D facility of any light-metals company anywhere. Alcoa—possessor of the biggest complex of aluminum fabricating plants in the world. Alcoa—staffed in depth to go to work immediately on research, development, production engineering or production of any defense requirement.

Aluminum—metal for mobility. How can we help you use it to best advantage? Write: Aluminum Company of America, 1875-J Alcoa Building, Pittsburgh 19, Pa.

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Minuteman Transporter-Erector. Prime Contractor—Boeing Airplane Company, Seattle Wash. Missile Container—Military Div. of Cessna Aircraft Co., Wichita, Kansas. Tractor & Trailer—GMC Truck & Coach Div., Pontiac, Mich.

MAGNESIUM LIGHTENS MINUTEMAN CARRIER...

helps keep it rigid

This huge transporter-erector will carry a Minuteman missile to its launching site, then raise it vertically, ready for placement in the underground launching silo. Magnesium was selected for many critical parts because of its stiffness and light weight . . . about 2250 pounds of sheet, plate and extrusions. This is 400 pounds *less* than the weight of the material originally considered.

The container must be light to meet highway load limits and rigid to protect the missile. For these reasons, all side panels, rear doors and access doors are made from magnesium AZ31B alloy sheet.

In the tractor unit, magnesium sheet and extrusions form the framework, panels, roof and floor. *Even the bumper* is of strong, lightweight magnesium alloy. Wherever a combination of light weight and stiffness is needed . . . for vehicle bodies, containers, housings, aircraft and missile structures . . . there's a Dow magnesium alloy to do the job. For information, write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Dept. 1113DF9.

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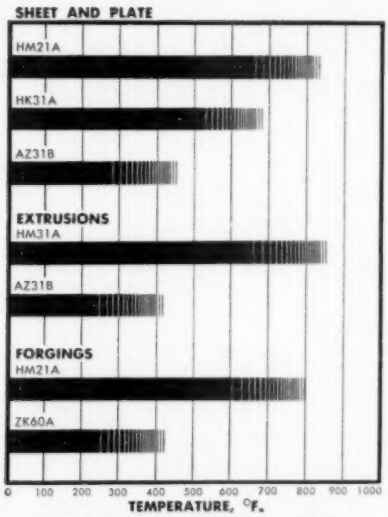

How thorium has extended magnesium's useful service temperature range.

High service temperature range and light weight . . . designers of missiles and aircraft can count on both with Dow magnesium-thorium alloys for elevated temperature use. This family of alloys offers strength and resistance to creep at high temperatures. Magnesium-thorium alloys are used in the Polaris, Titan, Talos and Bomarc missiles; in Agena and Scout vehicles; and in the F-105 aircraft.

Forgings of Dow alloy HM21A have excellent mechanical properties up to 800°F. Other alloys for extrusions, and sheet and plate, are available for use in the 300°— 800°F. range, for body skins, ducts, cowlings, electronic equipment housings, wings, fins and other applications.

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son, Boston Capital Corporation, Boston, Mass. This sixteenth annual meeting of the Division was sponsored by the Albuquerque Operations Office of the Atomic Energy Commission.

At the conclusion of the meeting, Mr. Thompson was succeeded as Division chairman by H. C. Biggs, Sandia Corporation, Albuquerque. Col. W. J. Darmody, U.S.A. (Ret.), Sheffield Corporation, Dayton, Ohio, was named deputy chairman, and J. C. Moody, Sandia Corporation, became secretary.

The meeting opened with a series of technical papers presented by government and industry experts in metrology. John J. Riordan, Office of the Assistant Secretary of Defense (Supply and Logistics), Washington, D. C., discussed "The Department of Defense Standards and Reliability Program." He was followed by Dr. W. J. Youden, National Bureau of Standards, Washington, D. C., who spoke on "Systematic Errors in Standards of Measurement."

The third speaker, Lieut. Col. K. M. Johnston, Air Matériel Command, Wright-Patterson Air Force Base, Ohio, presented "Relationship Among Calibration, Quality, and Reliability in Production."

The next paper, "An Ideal Approach to Electronic Metrology," was submitted by Dr. R. W. Stolzenbach, Dayton Air Force Depot, Ohio, who was followed by Charles E. White, Avco Corporation, Wilmington, Mass., who discussed "A Practical Experience in Electronic Metrology."

The sixth paper, by Col. W. J. Darmody, U.S.A. (Ret.), discussed "An Ideal Approach to Dimensional Metrology," and the final paper, "A Practical Experience in Dimensional Metrology," was prepared by Joseph L. Bolster, General Electric Company, Pittsfield, Mass.

The luncheon was featured by the presence of Dr. A. V. Astin, Director, National Bureau of Standards, Washington, D. C. Dr. Astin reported on the International Conference on Weights and Measures held in Paris in October 1960, particularly with regard to the momentous decision to adopt the wave length of the orange-red line of krypton 86 as the new international standard of length.

Following afternoon seminars conducted by the Section chairmen, the Division joined the Albuquerque Post, A.O.A., at at reception and dinner which it sponsored. The guest of honor was Dr. Gerald W. Johnson, associate director, Lawrence Radiation Laboratory, Livermore, Calif., who spoke on the peacetime applications of atomic energy.

On the second day, conferees heard reports from the seminars and a panel discussion. These were followed by tours of the testing facilities and the standards laboratories of the Sandia Corporation.

Quad Cities-Iowa Post Hears Talk On Space Medicine At Dubuque Meeting

The spring meeting of the Quad Cities-Iowa Post was held on May 26th at the Dubuque Elks Club Auditorium in Dubuque, Iowa, in keeping with the Post's policy of conducting meetings in the various industrial centers of its area. Approximately 110 members and their guests were present.

Post President A. Linton Lundy opened the meeting with a reading of the preamble to the A.O.A. constitution and supplemented it with remarks relative to the activities of the Business Defense Services Administration, a meeting of which he recently had attended in Washington, D. C.

The report of the nominating committee was given by Maurice A. Fraher, and the following nominees were unanimously elected: President, Victor B. Day; vice president, George A. Lewthwaite; directors, Philip S. Munford, Mr. Fraher, A. Linton Lundy, Jr., Floyd B. Selensky, Robert A. Harvey, Martin Strieter, Alex Matheson, Frank McGuire, L. M. Gildea, Gifford Mast, A. A. Zuber, and James Pearre.

Mr. Lundy then introduced the guest speaker, Dr. Constantine D. J. Generales, Coordinator of Space Medicine Research for New York Medical College, who presented a discussion on the dynamics of space medicine.

Dr. Generales began his presentation by outlining the phenomenal increase in interest shown in space and space-medicine subjects recently, as indicated by the large number of papers on these subjects being presented at technical and medical meetings. He described some of the early steps taken in the use of oxygen at high altitudes, and pointed out that some of these experiments had proved fatal to the test subjects.

Outlining the subject of "G" loading tolerable to the human anatomy, he showed that these tolerances are dependent both upon the position and support of the body frame, as well as upon the length of time the loading is imposed. Dr. Generales further delineated this part of his talk with slides showing the flow of blood and displacement of organs during various "G" loadings.

Some of the slides dated back to 1931,

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Robert McCulloch
Chairman of the Board

Gifford K. Johnson
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Clyde Skeen
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Attending the Forty-third Annual Meeting of the Association in Los Angeles, Calif., are, left to right: Rear Adm. P. D. Stroop, Chief, Bureau of Naval Weapons; Lieut. Gen. J. H. Hinrichs, Chief of Army Ordnance; J. E. Trainer, A.O.A. president; Vice Adm. C. L. Melson, Commander, First Fleet; Col. Henry N. Marsh, A.O.A. vice-president; and Frank Mayer, president of the Los Angeles Post which was host to the meeting. Admiral Melson spoke at luncheon and Admiral Stroop at dinner.

when he carried out experiments in cooperative action with Dr. von Braun to determine damage to organs of mice subjected to extreme "G" loads. These experiments definitely pointed out that growth of body tissue and bone structure will be stunted under this type of environment, such as may be experienced on other planets.

He described some of the effects of radiation, not only upon human tissue, but also upon the metal structure of which a spacecraft presumably will be constructed. He pointed out the disastrous explosion effect that may be expected from a small (pinhole) type of leak in a metallic structure at extreme altitudes and noted that the U.S.S.R. was conducting experiments in this field as far back as 1951.

Some of the troublesome effects on the human anatomy that may be expected from a prolonged weightless environment, he reported, are loss of protein in the organ and tissue system and loss of calcium in the bones. The effect of this environment on plant life also can be deleterious both because of weightlessness and radiation.

Dr. Generales outlined the status of the Saturn project and showed slides depicting the construction of the Nova nozzle. He pointed out that either or both of these projects might become obsolete due to the development of better solid propellants in the future.

He described the principle of an apparatus in which he is presently deeply involved, the Biocyclothonatron, which combines the factors that will be experienced in space flight. These experiments will be conducted on living organisms, constantly in motion in a space environment.

Dr. Generales concluded by stating that in the near future, with proper care, man's life span may be expected to reach 125 years as a normal condition.

Language Barrier Is Probed By A.O.A. Technical Publications Committee

A major problem of the United Nations —communication through the language barrier—was introduced to the April 26th meeting of the Special Committee on Technical Publications. Twenty-five Committee members and guests, assembled in Washington, D. C., received this and other key problems of broad scope from Government representatives.

Committee Chairman C. W. Lytle, Lytle Corporation, Albuquerque, N. Mex., opened the meeting by announcing the names of newly designated officers. The Committee deputy chairman is Arthur G. Norris, Vitro Engineering Company, New York, N. Y. Designated as secretary is John Hansell of the Washington office of Lytle Corporation, who will be backed up by assistant secretary J. D. Givens of the Albuquerque home office of the Lytle Corporation.

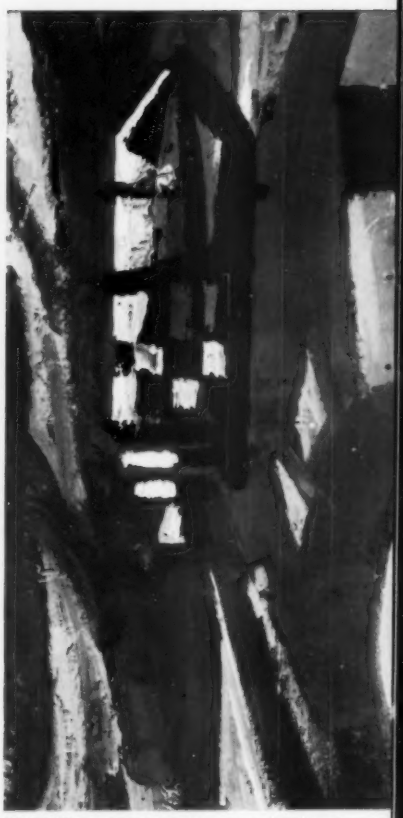
Standing subcommittee chairmen are: Maintenance Publications, R. A. Johnstone, Allison Division, GMC, Indianapolis, Ind.; Operator Publications, D. A. Drenth, Ingersoll Division, Borg-Warner Corporation, Kalamazoo, Mich.; Supply Publications, P. B. Lundstrom, Milmanco, Inc., Renton, Wash.; and Training Publications, Mr. Norris, in addition to his other duties.

Two ad hoc committees have been established, with S. W. Arwine, McLaughlin

(*Continued on p. 244*)

DISCOVERER SERIES Position gyros to aid vital satellite recovery programs have been developed and produced for this series by General Precision.

EXPLORER SERIES Over 20 General Precision components have assisted in the launching of these satellites.



MIDAS General Precision has developed and is now producing control moment gyros to stabilize MIDAS satellite with reference to earth when satellite is in orbit.

The major systems interpreted here are testimonials to General Precision's experience in space. The four divisions of General Precision, Inc., are represented by some system, subsystem or component on nearly every satellite, space vehicle, missile and rocket now in operation or development.

All of the corporation's facilities are consolidated for the systems management of major new space and weapons projects. Thus, the comprehensive General Precision capability is now at a new peak potential. As a result, a satellite or space vehicle program can draw upon the services of more than 16,000 General Precision employees (including 4,500 scientists, engineers and technicians) and well over 2½ million square feet of combined floor space.

This combination of talents and facilities, backed by the corporate financial resources of General Precision, Inc., makes it possible to develop, produce and manage a space system from concept to application.

GENERAL PRECISION AND SPACE

CENTAUR A 32-lb. digital computer with a displacement of less than 0.6 cubic foot has been developed and is now being produced by General Precision for this space vehicle's guidance system.

VENUS STUDY A balloon-borne optical astro-tracker developed and produced by General Precision is being used in a series of explorations to photograph Venus for the first time from outside the earth's atmosphere.

13" by 18½" reproductions of these original paintings, suitable for framing, are available on request. Please write on your company letterhead.

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Association Affairs (Contd.)

Research Corporation, Washington, D. C., heading a committee to recommend standards of levels of writing which will be generally acceptable in the industry.

J. D. Duffy, Cushing & Nevell, Inc., New York, N. Y., will head a committee to investigate reports on the technical publications subject and to inform all members thereof to assure full background knowledge and to avoid repetition of work already done.

The Committee heard John C. Lawlor, Armed Forces Supply Support Center, Washington, D. C., discuss the problems of cost-estimating for manuals of overly elaborate manuals, inadequate manuals, and unqualified bidders.

Several Air Force problems were presented by Lieut. Col. R. D. Stevens, U. S. Air Force Headquarters, Washington, D. C. The first was the minimization of duplication and costs between research and development, and training. The timely processing of manuals to the troops in the field was next discussed, and was followed by discussions of supply data, operator data, and flight handbooks.

The chairman of the Engineering Documentation Section, Production Techniques Division, W. W. Thomas, Radio Corporation of America, Moorestown, N. J., made several recommendations to the Committee based upon his past experience. Subcommittees then met separately to initiate plans for their activities and to report thereon at a later date.

Steering Committee Of Precision Gear Section Probes Current Problems

The Steering Committee of the newly reconstituted Precision Gear Section, Critical Components Division, recently held two meetings within six weeks. Recognizing the need for prompt organizational action and early solutions to current gear problems, Chairman Carl H. Parker, Fellows Gear Shaper Company, Springfield, Vt., called the second meeting on June 21st.

J. P. Gillilan, New Departure Division, GMC, Bristol, Conn., chairman of the Critical Components Division, opened the meeting with a specific problem involving design dimensions and tolerances, the need for industry standards, and the lack of suitable measuring equipment.

From this specific basis, discussion moved to the scope of Section responsibility and a statement of its capabilities. Coordination of Section work with other Divisions and Sections, such as the Research Division and the Standards and Metrology Division, also was investigated, as were Section relationships with outside agencies.

Col. Earl Wiley, chief of the Standardization Division, Armed Forces Supply Support Center, addressed the meeting. He discussed the standardization programs of the Department of Defense and also offered to assist in arranging for the participation of AFSSC personnel in meetings.

Mr. Parker made the following appointments: C. A. Underwood, Raytheon Company, Wayland, Mass., chairman, subsection on gears and motors, with volunteers E. Fox, AC Spark Plug Division, GMC, Milwaukee, Wis., and F. N. Juarbe, Atlas Precision Gear Products, Philadelphia, Pa., as members; Mr. Fox and Mr. Gillilan to investigate lubricants; Paul Levi, Radio Corporation of America, Moorestown, N. J., and Mr. Underwood to draft a scope of activity for the Section. Mr. Underwood also volunteered to serve as liaison representative to the Documentation Section.

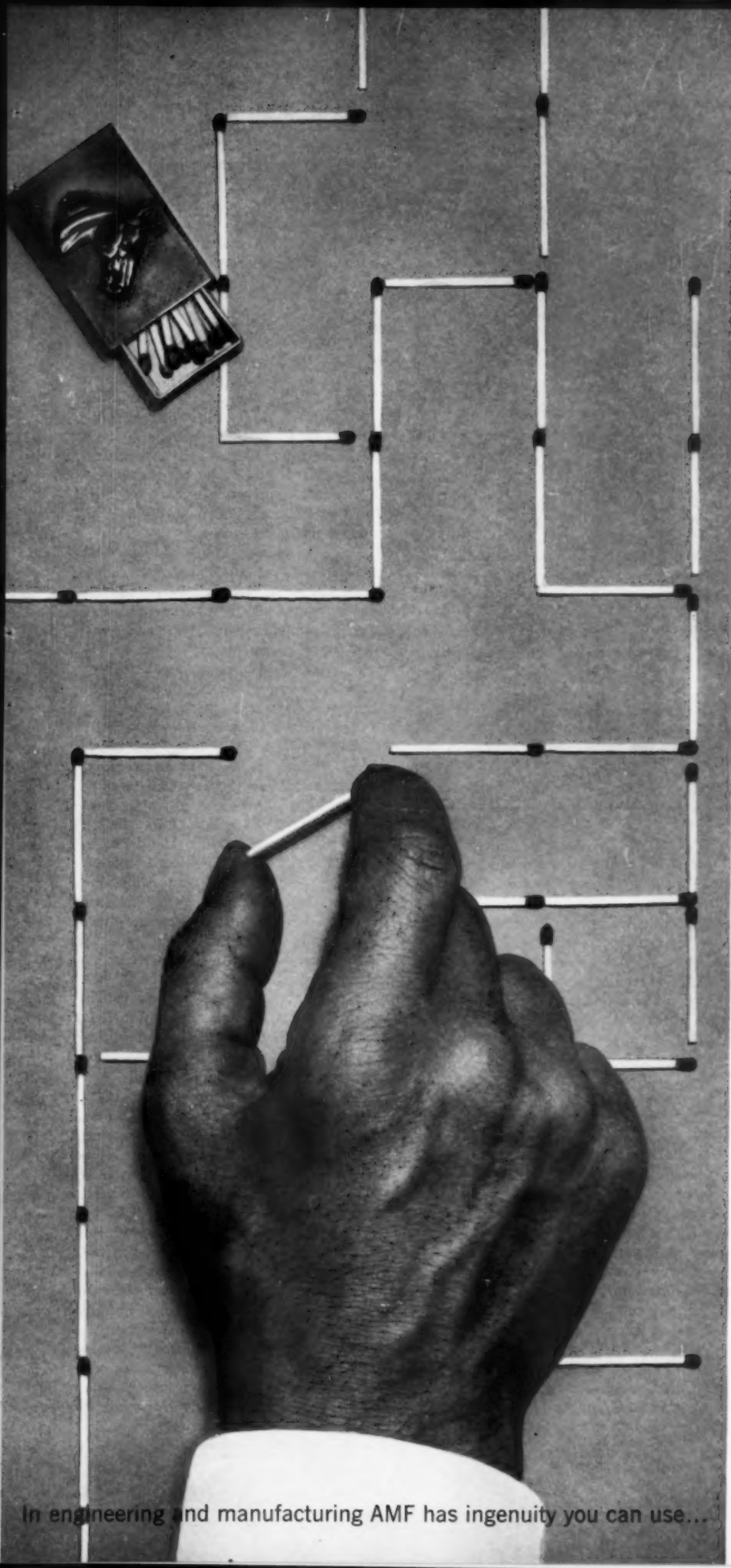
Modern Techniques Studied During Meeting Of Packaging Division At Rossford Depot

Modern techniques of packaging ordnance matériel were subjected to the scrutiny of 114 packaging experts at Rossford Ordnance Depot, Toledo, Ohio, on June 6th and 7th. These packaging engineers had assembled from across the Nation to attend the meeting of the Packaging Division called by Chairman Thomas P. Wharton, Packaging Consultants, Inc., Washington, D. C.

A series of technical papers on "The State of the Art of Ordnance Packaging" was then presented for different ordnance commodities. I. H. Osborn, Librascope Division, General Precision, Inc., Glendale, Calif., discussed fire-control packaging. Artillery packaging was then reviewed by Joseph Diehl, International Harvester Company, Rock Island, Ill., and Edwin E. Gillen, Rock Island Arsenal, Ill.

Robert J. Sefing, Minneapolis-Honeywell Ordnance Division, Duarte, Calif., presented a paper on underwater ordnance packaging. This was followed by a paper on electronics packaging by Paul M. Boyer, Westinghouse Electric Corporation, Baltimore, Md., and George Civille, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

The packaging of combat and tactical vehicles was reviewed by Paul V. Ford,



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His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4 x 8 matrix that can be mounted in a 19" rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

To insure fail-safe operation, power is required for the vacuum switches *only* during change of condition. Selection rate: 1 per second. Operating transmitters are safety-interlocked to insure a load. There are no hazards from open wires or inadvertent application of power to dead-lined antennas.

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- *Range Instrumentation*
- *Space Environment Equipment*
- *Nuclear Research & Development*

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Association Affairs (Contd.)

J.H.S. Packaging Company, Pittsburgh, Pa., and Clair L. McDermit, Ordnance Tank-Automotive Command, Center Line, Mich. Small arms and small-arms ammunition packaging was presented by a 4-man team, including Al Travostino, Remington Arms Company, Independence, Mo.; George A. Mahr, Office, Chief of Ordnance, Washington, D. C.; W. Rose and A. Cahill, Frankford Arsenal, Philadelphia, Pa.

Harvey C. Simms, Zero Manufacturing Company, Silver Spring, Md., and Howard W. Weiner and Robert G. Leonardi, both of Picatinny Arsenal, Dover, N. J., discussed packaging for bombs, warheads, and artillery ammunition.

The industry phase of packaging missile items was discussed by T. C. Combs, Zero Manufacturing Company.

Fay Alford, San Bernardino, Air Matériel Area, Norton Air Force Base, Calif., spoke for the Air Force, while Norman A. Junker, Bureau of Naval Weapons, Washington, D. C., presented the Navy phase. The Army spokesman was John W. O'Donnell, Army Ballistic Missile Agency, Redstone Arsenal, Ala.

The meeting attendees at dinner that evening had the opportunity to hear Raymond A. Norris, chief, Materials Division, Packaging Programs Branch, Armed Forces Supply Support Center, Washington, D. C., discuss packaging problems.

On the second day, meetings of the Sections and reports by their chairmen constituted most of the agenda. However, members were able to meet Maj. J. J. Kasmer, chief of the Ordnance Packaging Agency, and his deputy, N. J. De Mars.

A.O.A. Honors Outstanding R.O.T.C. Cadets With Scholarship Key Awards

Each year the honor Ordnance cadets in the R.O.T.C. units in colleges throughout the country are awarded the American Ordnance Association Scholarship Key. The awards were made to the students named below during graduation exercises at the following institutions:

University of Arizona.—Cadet Lieut. Col. Frank H. Scussel, Denver, Colo., majored in mechanical engineering. He is a distinguished military student, member of Scabbard and Blade and the Theta Chi Social Fraternity. His branch assignment in the Army is in Ordnance.

Arlington State College.—Cadet Col. Roger D. Kannady, Ada, Okla., was designated a distinguished military student. He is a member of the ASC Engineering Society and Epsilon Nu Gamma Fraternity. He is also outstanding in the work of the Arlington Junior Chamber of Commerce.

Bucknell University.—Cadet Kenneth Lee Hoover, Williamsport, Pa., majored in mechanical engineering. He is a member of Theta Chi Fraternity and served as representative in the Men's Student Government. In addition, he belongs to the American Society of Mechanical Engineers and the Pershing Rifles.

University of California.—Cadet Capt. Douglas H. Tanimoto, Los Angeles, Calif., is majoring in physics and is planning to do graduate work in physics at the University of Oregon. He participated in intramural sports and was a member of the judicial council. He plans to enter the Army Ordnance Corps in the field of research and development.

Canisius College.—Cadet Lieut. Col. Stephen A. Maggio, Buffalo, N. Y., a distinguished military student, had the highest rating of any Canisius cadet at R.O.T.C. summer camp in 1958. He has been active in many of the campus activities and has accepted a regular Army commission in Ordnance with a detail in Armor upon graduation.

Clemson Agricultural College.—Cadet Capt. Thomas Mitchell Osmer, Lake City, S. C., majored in electrical engineering. He was active in sports, especially varsity football, and the following fraternities: Phi Eta Sigma, Phi Kappa Phi, and Tau Beta Pi. He received the Tau Beta Pi Scholastic Award, AIEE-IRE Scholastic award, and the SAME merit award. He obtained highest honors during his four years academically and is listed in "Who's Who among College Students."

Dartmouth College.—Cadet Arthur A. Kolakowski, New Brunswick, N. J., is a government major. He participated in varsity football, is a member of Phi Beta Kappa and Phi Gamma Delta fraternities. He plans to do graduate work at Duke University.

University of Detroit.—Cadet Lieut. Col. Anthony V. Bertolino, St. Louis, Mo., is in the College of Engineering, majoring in electrical engineering. He is a member of the Eta Kappa Nu Fraternity and the University of Detroit Band. He was an honor student in the R.O.T.C.

University of Cincinnati.—Cadet Lieut. Col. Joseph Lee Kenty, Cincinnati, Ohio, has been designated a distinguished military student. He was a member of Scabbard and Blade, Pershing Rifles, Phi Eta Sigma, Tau Beta Pi, and American Society for Metals. He majored in metallurgical engineering and plans to accept a commission in the Army Ordnance Corps.

The Citadel.—Cadet Capt. Lawrence F. McDaris, Jr., Cleveland, Tenn., is a distinguished military student. He served as

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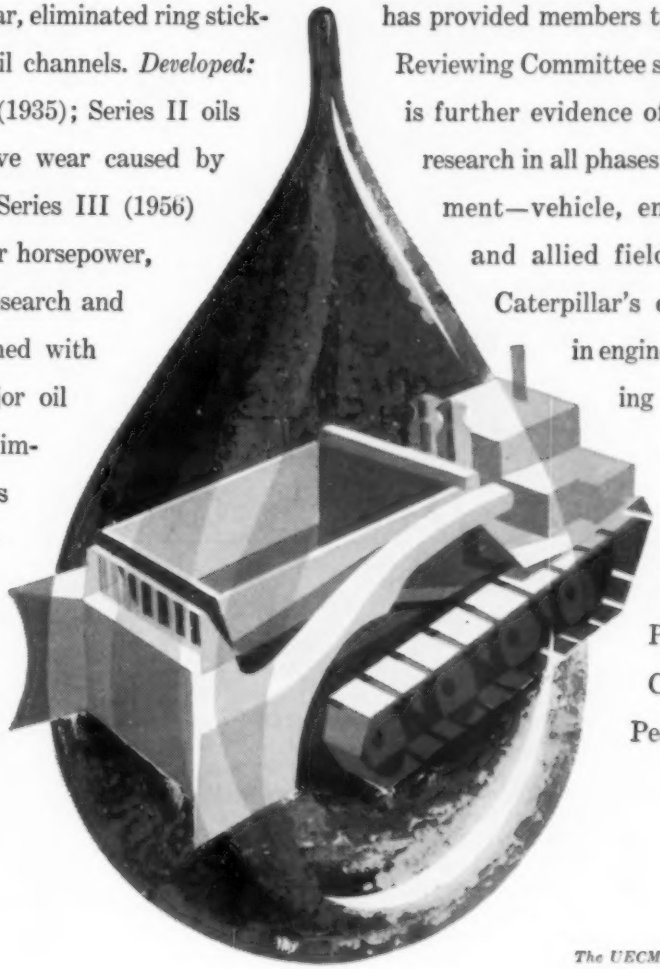

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Association Affairs (Contd.)

sports editor of *The Guidon* and was a member of the Summerall Guards, a select drill team. Cadet McDaris has accepted a commission as second lieutenant, Ordnance Corps, in the Regular Army.

Claremont Men's College.—Cadet Lieut. Col. Donald James Gross, La Jolla, Calif., will receive his major in chemistry. He is a member of the American Chemical Society and a distinguished military student. He plans to attend the University of North Carolina as a graduate student in chemistry to obtain his doctor's degree in chemistry after serving a tour of duty in the Ordnance Corps.

Eastern Kentucky State College.—Cadet Lieut. Col. Carl P. Cole, Lexington, Ky., majored in mathematics and physics. He led his class academically for seven semesters with a perfect 3.0 average. He has demonstrated outstanding leadership qualities and has excelled in athletics, especially in basketball, being named an honorable-mention all-American. He plans to do graduate work in engineering.

Florida Southern College.—Cadet Col. Frederick T. Mullens, Chattanooga, Tenn., majored in business administration. He is a member of the Pi Kappa Alpha Fraternity and also Delta Sigma Pi. He is accepting a commission as second lieutenant in the Army Ordnance Corps.

Georgia Institute of Technology.—Cadet Lieut. Col. James G. Wright, Jr., Forsyth, Ga., has been designated a distinguished military student. He is a member of the Briaerean Society, Pi Tau Sigma, Tau Beta Pi, Phi Kappa Phi, and a member of the glee club. His major is mechanical engineering, and he commanded the Georgia Tech Composite Battalion composed of the best platoons from each of the six arms and services at Georgia Tech.

University of Georgia.—Cadet Lieut. Col. Augustine Patterson Little, III, Fort Benning, Ga., has been designated a distinguished military student. He is a member of Sigma Alpha Epsilon, Scabbard and Blade and was chairman of various campus social activities. He has been selected for a commission in the Army Ordnance Corps.

Gonzaga University.—Cadet Lieut. Col. Donald J. Remen, Lodi, Ohio, is a distinguished military student and majored in mechanical engineering. He was assigned as the adjutant of the Cadet Brigade, served on the cadet judiciary board, and was appointed a battle group commander while in the advanced R.O.T.C.

University of Idaho.—Cadet Weldon Reynolds Tovey, Malad City, Idaho, is a distinguished military student. He majored in mechanical engineering. He was a member of the National Student Association Committee and pledged to Phi Gamma Delta Fraternity. He was a member of the Scabbard and Blade honorary society. He will be commissioned as a Regular Army officer in the Ordnance Corps.

University of Illinois.—Cadet Lieut. Col. Jerry J. Smith, Oblong, Ill., has been designated as a distinguished military student. He is a member of the Phi Lambda Upsilon and Phi Kappa Phi honorary fraternities as well as vice-commander of the Phalanx Military Fraternity. His scholastic record, military leadership, and interest in campus activities were of the highest order.

University of Kansas.—Cadet Lieut. Col. Jerry Dean Roberts, Kearney, Nebr., has been designated a distinguished military student. He is majoring in industrial management and is on the Dean's Honor List. He is an active member of Sigma Nu, Alpha Kappa Psi Fraternities and Scabbard and Blade. He belonged to the university varsity rifle team as well as the R.O.T.C. rifle team.

Knox College.—Cadet Col. James Thomas Madej, Chicago, Ill., was designated as a distinguished military student. He majored in mathematics and was a member of the French and German Clubs, Phi Beta Kappa, and R.O.T.C. drill team. He will be assigned to the Army Ordnance Corps.

Lafayette College.—Cadet Ronald L. Smith, Frederick, Md., has been designated a distinguished military student. He has been on the dean's list each semester, is a member of the Eta Kappa Nu Engineering Fraternity and also the Kappa Sigma Social Fraternity.

Lehigh University.—Cadet William Brady Deem, Parkersburg, W. Va., was a member of the Alpha Phi Omega Service Fraternity, Pershing Rifles, and Sigma Chi Fraternity. He was named to the dean's list on three occasions and is a Phi Beta Kappa.

Massachusetts Institute of Technology.—Cadet Roger Angelo Lucheta, Louisville, Ky., majored in mechanical engi-

F. H. Scussel

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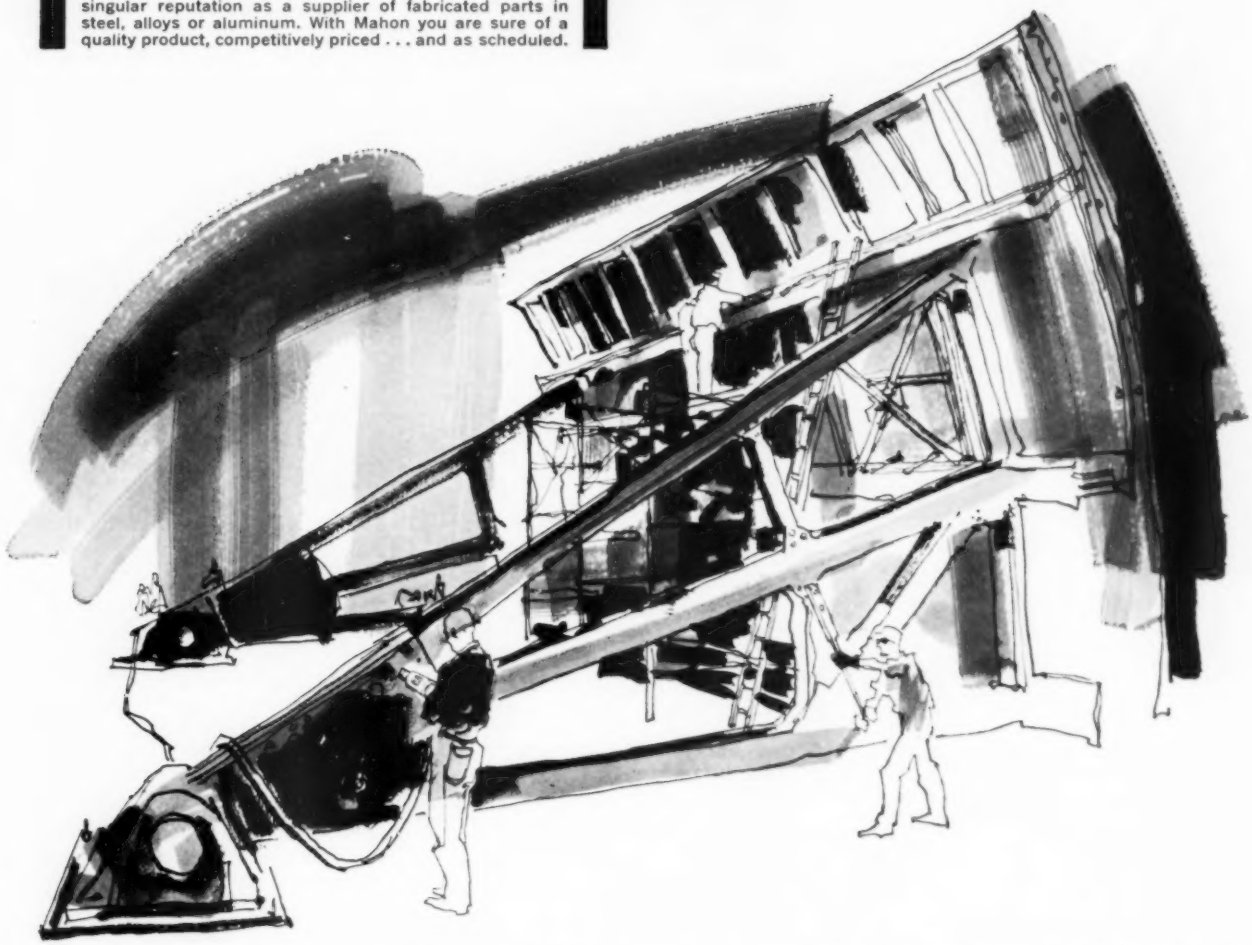

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F. T. Mullens

J. C. Wright, Jr.

Roger William Lutz, majoring in industrial engineering, has been designated as a distinguished military student. He served as sportscaster for the campus radio station and was sports editor for the *Spectrum*, the N.S.D.U student newspaper. He is a member of Sigma Alpha Epsilon Fraternity and was active in all intramural sports. He will be commissioned in the Army Ordnance Corps upon graduation.

University of Notre Dame.—Cadet Lieut. Col. Donald B. Rice, Jr., Frederick,

W. R. Tovey

A. P. Little, III

Md., is a distinguished military student majoring in chemical engineering. He has been granted a fellowship at Purdue University for postgraduate study. He has been on the dean's honor list, is listed in "Who's Who in American Colleges and Universities," and is a member of Tau Beta Pi Honor Society.

Ohio State University.—Cadet Maj. William Robert Felder, Cleveland, Ohio, attended the College of Engineering, majoring in industrial engineering and was designated a distinguished military student. He is a member of the Mershon Honorary Society, Kappa Sigma Fraternity, and the American Institute of Industrial Engineers.

University of Oklahoma.—Cadet Ste-

Association Affairs (Contd.)

neering, maintaining a straight "A" average in military science during his four years at the institute. He participated actively in a number of extracurricular activities, excelling in the sport of swimming. He expects to accept a Regular Army commission in the Ordnance Corps.

Mississippi State University.—Cadet Lieut. Col. John T. Moore has been designated a distinguished military student. He was president of Sigma Chi and Delta Sigma Pi Fraternities and was on the president's list. He was a member of Scabbard and Blade and is listed in "Who's Who among Students in American Colleges and Universities."

Missouri School of Mines and Metallurgy.—Cadet Col. John William Ricketts, Boonville, Mo., majored in mechanical engineering. He has accepted an appointment as second lieutenant in the Army Ordnance Corps after graduation. He was president of the Pi Tau Sigma Fraternity and vice-president of Kappa Sigma Fraternity.

North Carolina State College of A&E.—Cadet Lieut. Col. Stephen Stanley Koszewski, Jr., majored in metallurgical engineering. He is a member of the Pershing Rifles, Newman Club, and Tau Kappa Epsilon. He will be commissioned a second lieutenant in the Army Ordnance Corps.

North Dakota State University.—Cadet

S. A. Maggio

T. M. Osmer

J. L. Kenty

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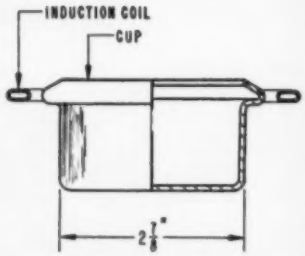

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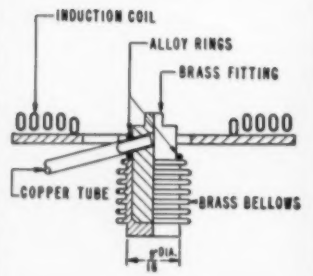

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J. D. Roberts

J. T. Madej

phen W. Winder is a distinguished military student, majoring in aeroengineering. He is a member of the Sigma Nu, Sigma Gamma Tau, and Phi Eta Sigma fraternities. He participated in intramural sports and was a distinguished military student while an undergraduate.

Oklahoma State University.—Cadet Lieut. Col. Robert John McCormick, a distinguished military student, will be commissioned in Army Ordnance upon

W. B. Deem

R. L. Smith

graduation. He majored military science while at the university

Pennsylvania Military College.—Cadet Capt. Lowell M. Hattori, a distinguished military student, was a member of the Pershing Rifles, the Political Science Club, and served on the staff of the college newspaper, *Dome.* After graduate study he will enter the service as a second lieutenant in the Army Ordnance Corps.

University of Santa Clara.—Cadet Maj. Paul John Ahern, San Francisco, Calif., is a candidate for a degree in electrical engineering. A distinguished military student, he is a member of the Engineering Society, the Irish Society, Scabbard and Blade, and the senior counseling service. He will be commissioned a second lieutenant in the Army Ordnance Corps.

South Carolina State College.—Cadet Isiah O. Sewell is scheduled to be com-

J. T. Moore

R. A. Lucheta

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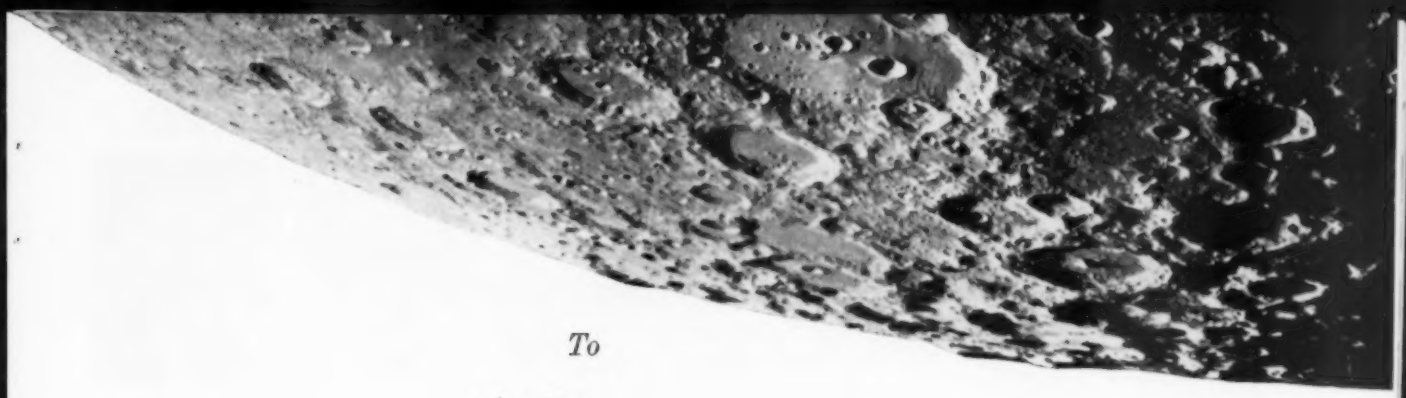

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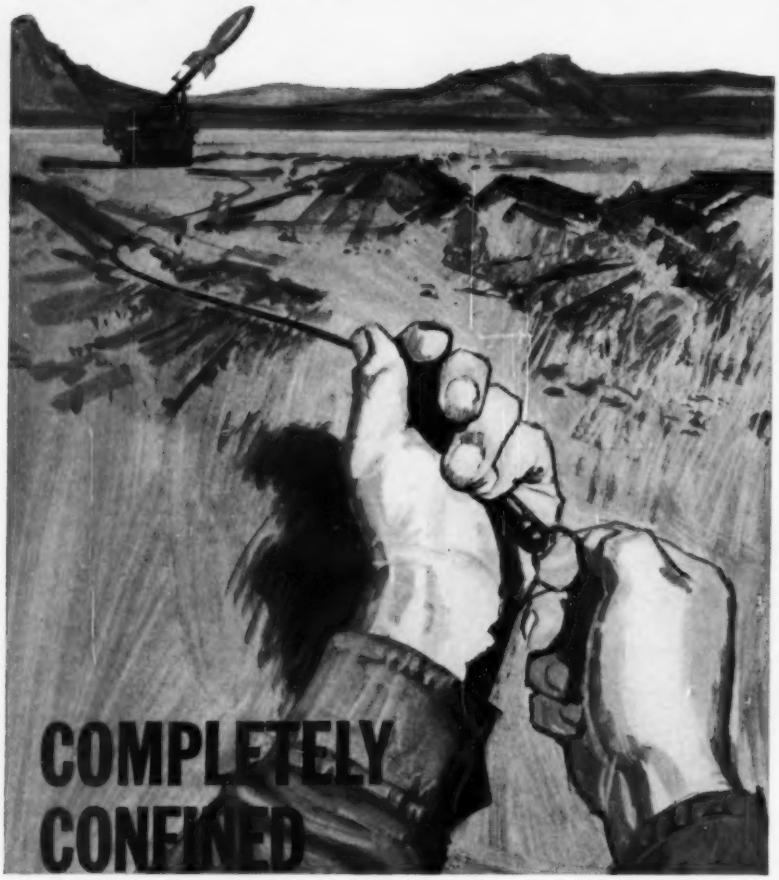

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missioned in the Ordnance Corps upon graduation. He was a member of the varsity football and track teams during his entire four years of attendance at the institution and participated in many campus sports activities as well as holding leadership positions in student organizations.

South Dakota State College.—Cadet Lieut. Col. Joseph Grant Morse, Colorado Springs, Colo., has been designated a distinguished military student. He was active in dramatics, speech, and musical activities and participated in intramural

R. W. Lutz

W. R. Felder

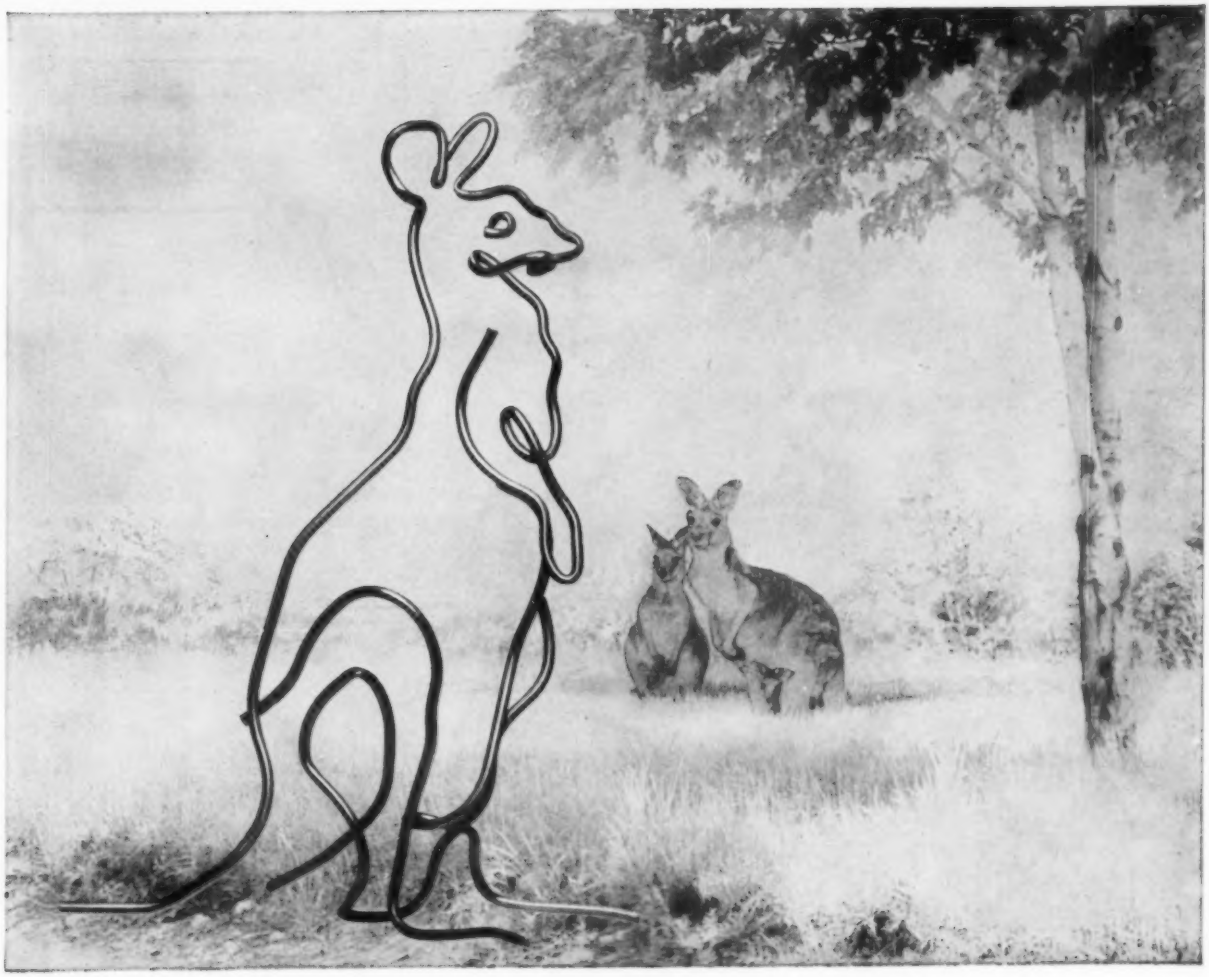
sports. He is listed in "Who's Who in American Colleges and Universities" and is a member of Scabbard and Blade and Phi Kappa Phi honor society.

Spring Hill College.—Cadet Capt. James Charles Chico, Shreveport, La., was designated an outstanding military student as he demonstrated qualities in leadership, military knowledge, and loyalty as an R.O.T.C. cadet. He majored in physics and is accepting an appointment in the Army Ordnance Corps upon completion of his college course.

Stanford University.—Cadet Maj. John William Warnock, Phoenix, Ariz., was designated a distinguished military stu-

S. W. Winder

L. M. Hattori



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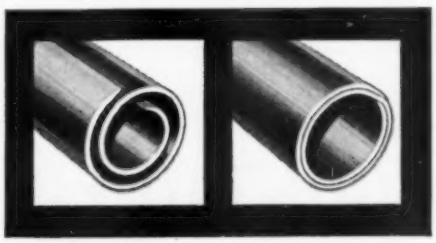

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P. J. Ahern

E. D. Schwankl

dent. He majored in political science and is presently a candidate for the Rotary International fellowship program. He served as president of his freshman residence hall and was associate editor of the *Scratch Sheet*. He plans to continue his education after his active military service.

St. John's University.—Cadet Elmer Donald Schwankl has been selected as a distinguished military student. He was

J. W. Warnock

J. G. Morse

active during his four years at the university in intramural sports. He is a member of the American Chemical Society and won the St. John's University Scholastic Ribbon and the St. John's University Expert Cadet Badge.

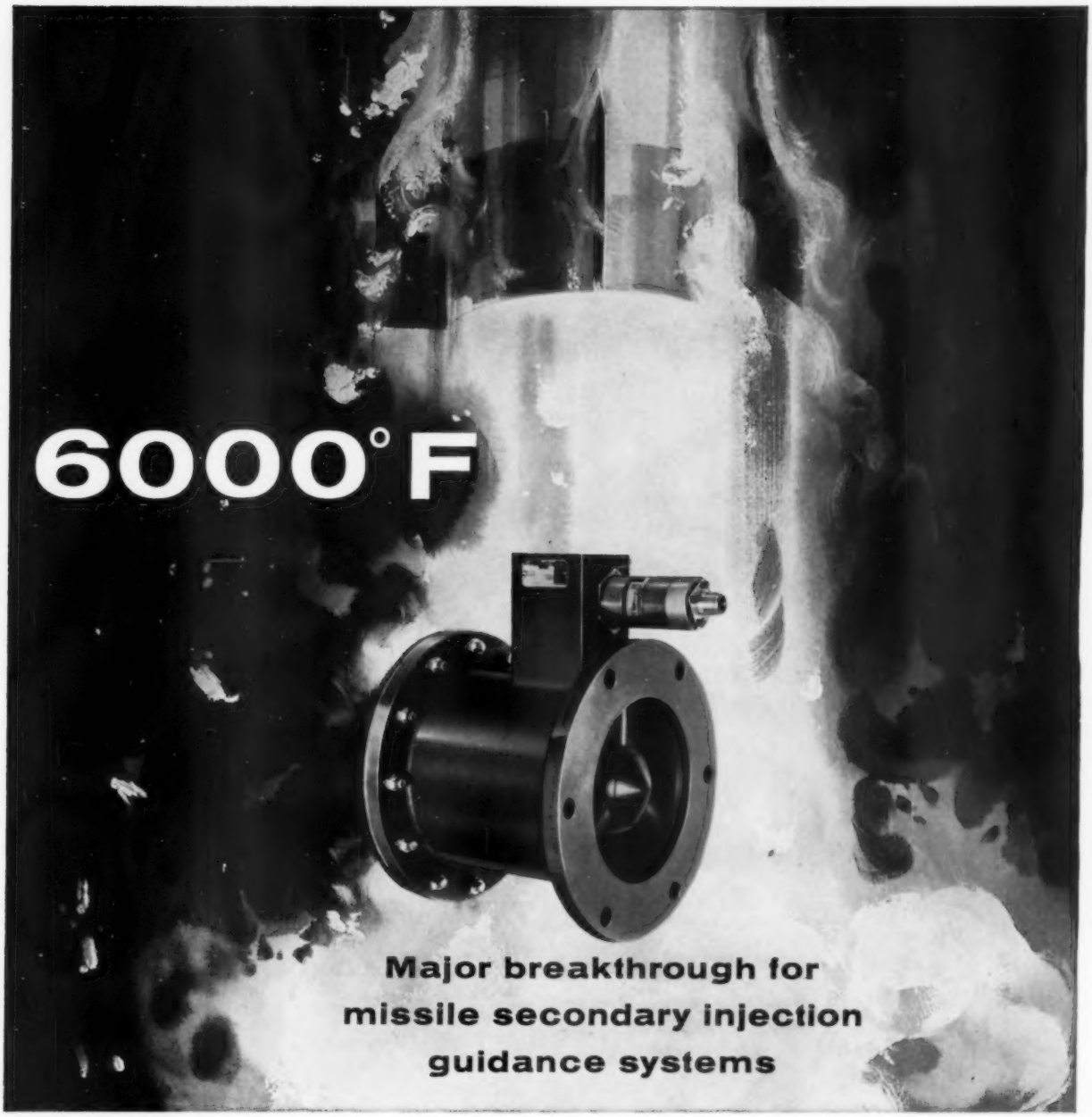
Syracuse University.—Cadet Capt. James Frederick Pasto, Franklinville, N. Y., has been designated a distinguished military student. He was vice-president of Eta Kappa Nu, president of Pi Mu Epsilon, and secretary of Tau Beta Pi. He was active in Phi Kappa Phi and the campus St. Thomas More Holy Name Society as well.

University of Tennessee.—Cadet Henry Alexander Henegar, Knoxville, Tenn., has been designated as a distinguished military student. He majored in English and was a member of Scabbard and Blade

(*Continued on p. 262*)

H. A. Henegar

J. F. Pasto



This AiResearch ultra-high temperature shutoff valve has been tested at 6000°F. Its development makes possible the use of secondary injection thrust vector control for greater simplicity and reliability.

This high temperature capability is an extension of previous AiResearch valve and controls experience in the —423 to 2000°F range, and further demonstrates over-all capability in the design of complete missile and ground support systems.

An inline poppet valve of extremely clean design has been produced to handle the high speed flow of hot, contaminated gas ducted from the combustion chamber to the exhaust nozzle. This design will: (1) keep lodging of contaminants to a minimum; (2) reduce turbulence and uneven wear; and (3) permit only a small pressure drop across the valve at maximum flow.

Growth into high temperature ranges can be accomplished by changes in material without changes in the basic valve design. The extreme compactness and light weight of the valve make it ideally suited for installation in the isentropic spike of a plug nozzle.

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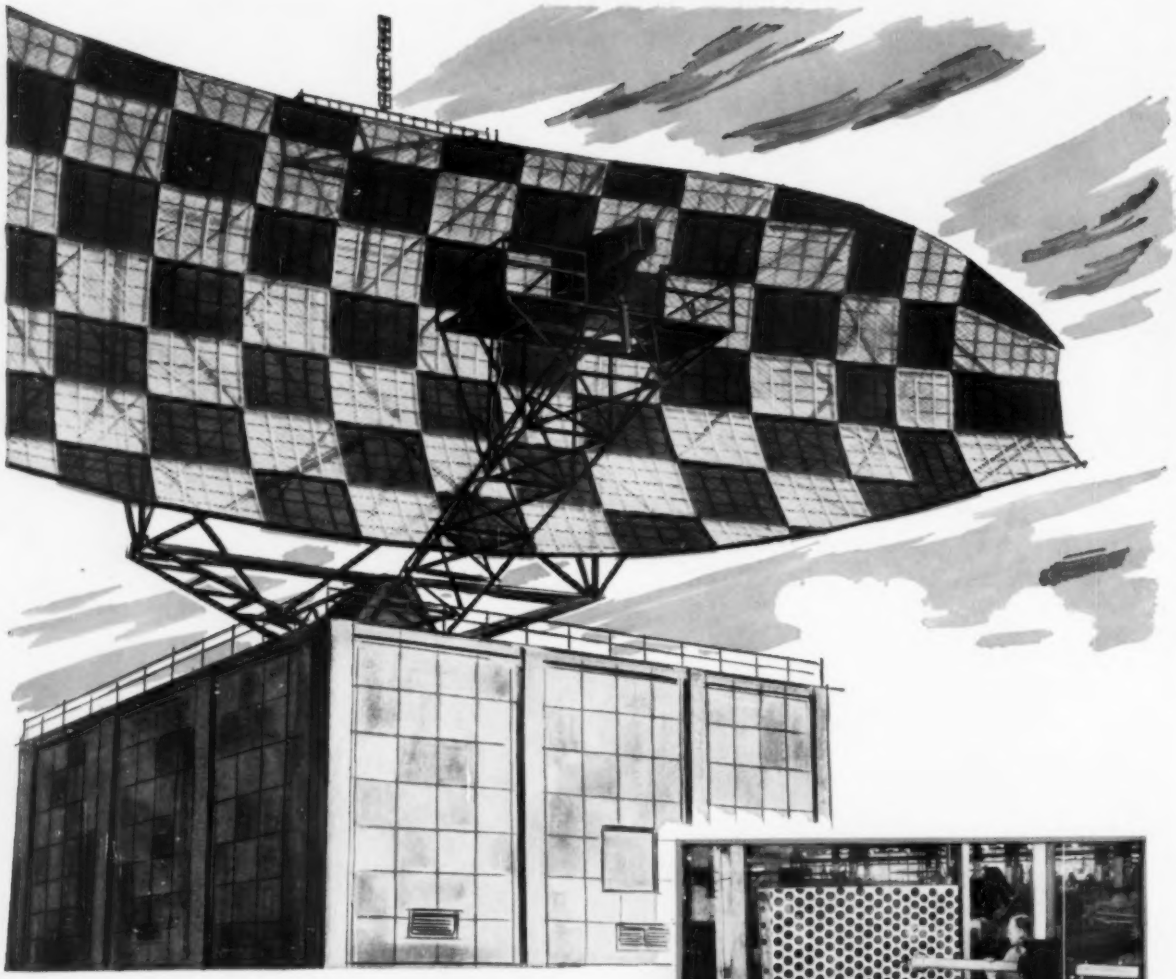
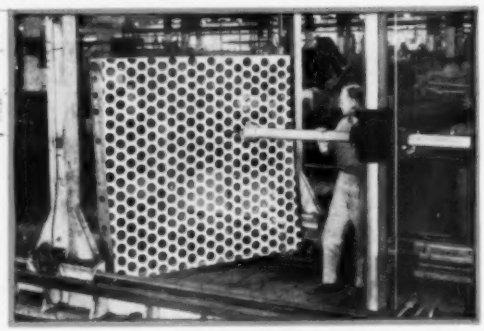


Sperry FPS-35 radar with antenna fabricated by B-L-H.

B-L-H fabricates giant USAF radar watchdogs



Portage machine, one of largest ever built, checks curvature of radar antenna panels, gives micrometerlike direct reading to within .010 in.

Eight huge steel antennas—each weighing nearly 70 tons, 38 ft. tall at midpoint, 125 ft. from blunted tip to tip—had to be fabricated. Sperry Gyroscope picked B-L-H. These antennas are the transmitting and sensing elements of the Sperry FPS-35 radars now being installed for the nation's new Air-Search Radar network.

Each antenna is faced with 101 panel sections, which consist of steel sheets perforated with 3-in. holes on 4-in. centers. Panels had to be fabricated with extreme care because construction to precise yet varying curvatures and sizes is vital in preventing cumulative tolerance errors that would seriously weaken the radar's capability. Some 50 different panel sections had to be made.

Most of the strength of the antennas, which must withstand 126 mph winds, is supplied by a network of supporting trusses. Fifty-two sizes of seamless steel tubing were used in constructing this pipework. And in fabricating the base structure, a steel ring of 149½-in. diam. had to be turned to a flatness tolerance of .003-.004 inch in 360 degrees.

Because of its broad experience, its enormous shop areas, and its unsurpassed facilities for the fabrication of large, unwieldy structures, B-L-H is able to carry out projects of this magnitude efficiently and economically. It will pay you to consult us. Write Dept. H-9 for further information and for illustrated literature.

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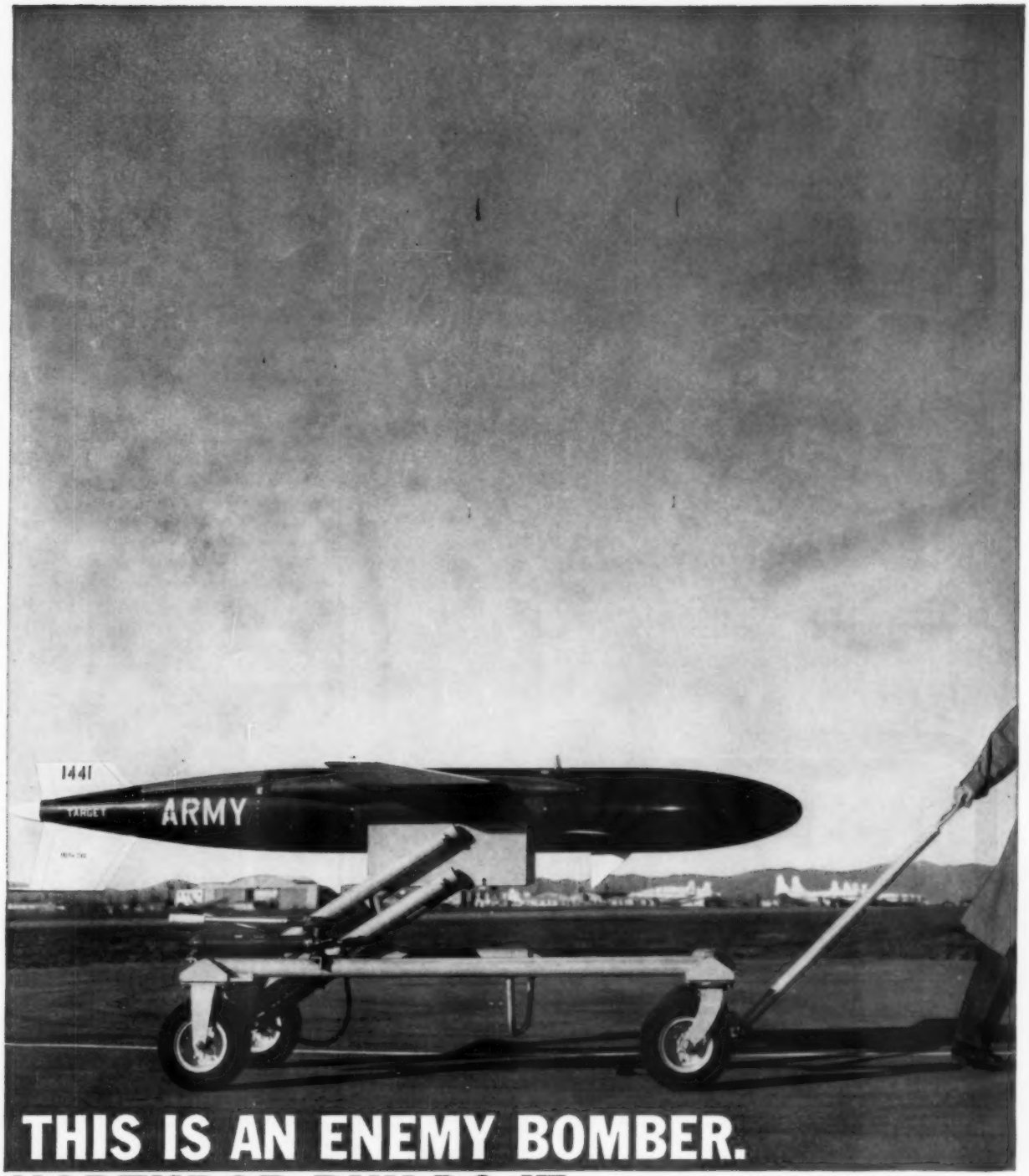

THIS IS AN ENEMY BOMBER. NORTHROP BUILDS IT.

On a radar screen, the RP-76 target missile can look as big as the largest enemy bomber. Rocket powered, it flies faster than sound, operates above 70,000 feet. Yet this little giant is less than ten feet long, weighs just over 300 pounds, and parachutes down for re-use after completing its run. It is the heart of the Army's program for training the ground-to-air missile crews who guard our cities. The complete target and tracking system is made, managed and serviced for the Army by **RADIOPLANE** A DIVISION OF **NORTHROP**

DETECTOTEMP PAINT
used on the X-15
YIELDS VITAL TEMPERATURE DATA

Major Robert White, shown standing next to DetectoTemp painted nose cone.

Color Changing Paint Indicates Surface Temperatures and Thermal Distribution

Prior to the historic X-15 flight, DetectoTemp paint was applied on the metal nose surface of the craft to record 'in-flight' skin temperatures. As the X-15 rocketed to 2905 mph, this unique paint progressively changed from its original green color to blue, yellow, black and finally brown as the surface temperature increased due to air friction.

This dramatic application emphasized the outstanding characteristics which have proved DetectoTemp ideal for all applications ranging from microminiature circuitry to large surface areas. Easy-to-see color changes represent definite temperature points and give DetectoTemp the unique ability to indicate local temperature variations.

For further information on how this amazing product can benefit your program, phone Swinburne 9-0500 or write.

DETECTOTEMP
Available in 4 oz. and 1 lb. metal cans. 36 types cover temperatures from 40° C to 1350°C. Multichange paints available with as many as 4 color changes.

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E. L. Wills

J. W. Cropp

and vice-president of Sigma Alpha Epsilon Fraternity. He has been assigned to Army Intelligence with the Ordnance Corps as his detail branch upon graduation.

Texas Technological College.—Cadet Edward Langston Wills has been designated as a distinguished military student. He was a member of AIEE-IRE, the Air Force drill team, and Scabbard and Blade. He will take a Regular Army commission in the Ordnance Corps.

Vanderbilt University.—Cadet Lieut. Col. John Williamson Cropp, Wolf Point, Mont., majored in geology. He was a member of the varsity football team and is vice-president of Kappa Sigma Fraternity. He has been designated a distinguished military student.

Virginia Military Institute.—Cadet Donald Reed Fany, Arlington, Va., has been designated as a distinguished military student. He has applied for a Regular Army commission and has been accepted by the Department of the Army for a commission in Ordnance with detail in Armor.

Virginia Polytechnic Institute.—Cadet Lieut. Col. Jack Melvin Mendel, Richmond, Va., is majoring in chemical engineering. He was cadet battalion commander, president of the American Military Engineers chapter, a member of Scabbard and Blade, and belonged to the Tau Beta Pi, Omicron Delta Kappa, Pi Delta Epsilon, and Phi Lambda Upsilon Societies.

Western Michigan University.—Cadet Maj. James L. Burnside, a distinguished military student, has been assigned to the Army Ordnance Corps. He was active in various activities of the Cadet Brigade and was an active member of the University Industrial Management Society. He majored in industrial engineering.

J. M. Mendel

J. L. Burnside

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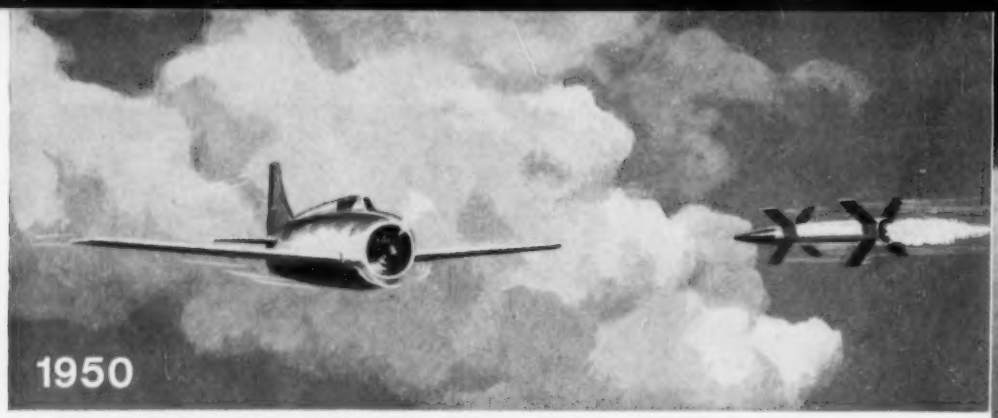
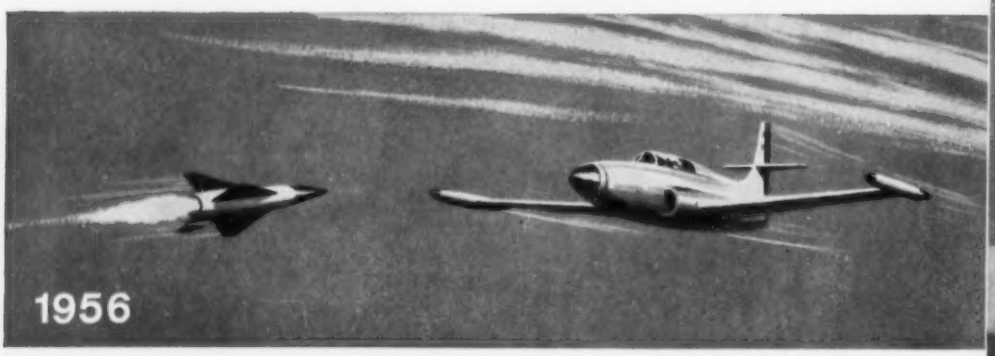
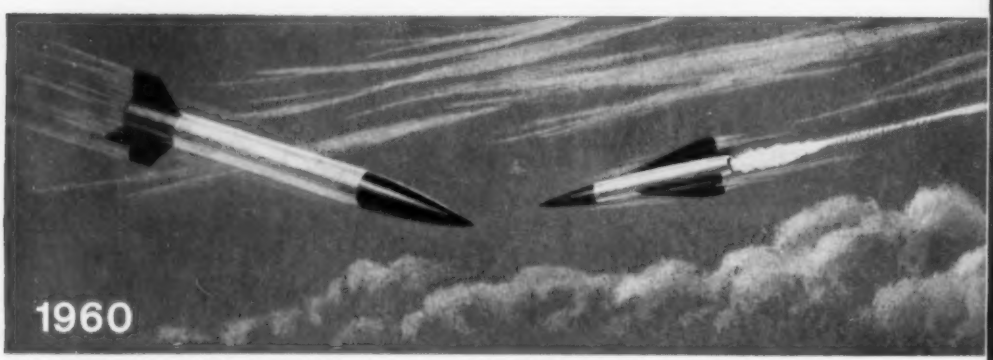


FIRST successful intercept of piston aircraft by guided missile...Raytheon's Lark.



FIRST successful intercept of jet aircraft by guided missile... Raytheon's Hawk.

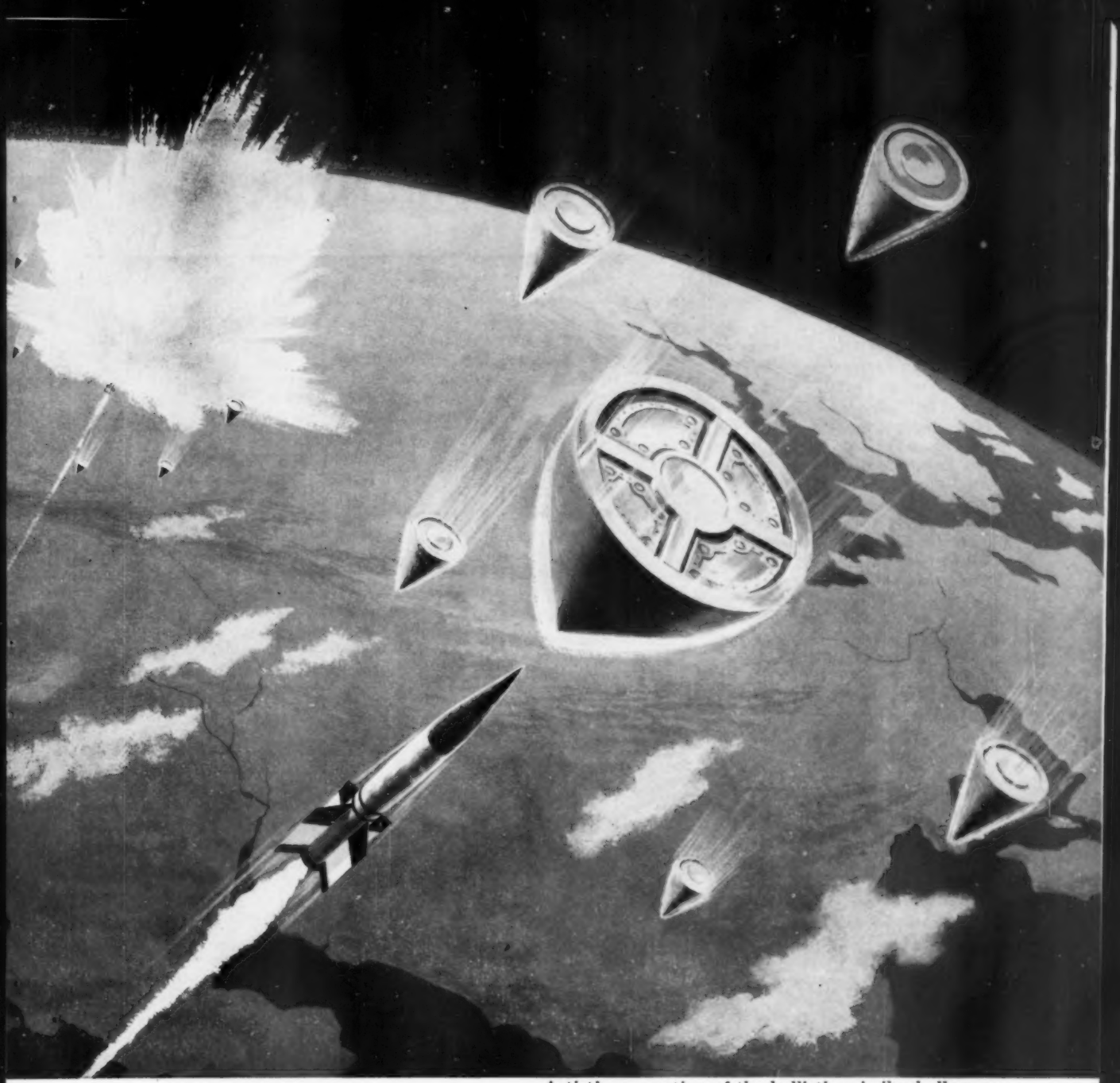


FIRST successful missile-to-missile intercept . . . Raytheon's Hawk.

Raytheon brings proven capability to the

Defense against ballistic missiles is one of today's most challenging technological problems. Raytheon, since its development of Lark in 1950, and its participation in 1954 in the Wizard studies, has been working on a broad technological front in the development of systems concepts and equipments for defense against missiles and aircraft.

The development and production by Raytheon, as prime contractor, of the U.S. Army and Marine Corps Hawk, and the U.S. Navy's Sparrow III missile systems, are part of this broad spectrum of defense system capability. Allied programs include study of



Artist's conception of the ballistic missile challenge.

challenge of ballistic missile defense

Field Army Ballistic Missile Defense, development of the PINCUSHION and COSAR Advanced Radar Systems, and responsibility as Systems Manager for the ARPAT Missile Defense Research Program.

One of the world's largest scientific-industrial organizations, Raytheon has the proven capability to create the required technology and manage every phase of a complex system — from early study and design through development, production and field support of operational systems and equipment. *Executive Offices, Lexington 73, Massachusetts.*

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MISSILE AND SPACE DIVISION

RAYTHEON

NEW DEVELOPMENTS

Hustler's Bomb-Fuel Pod

A series of test drops at speeds as high as Mach 2—more than 1,300 miles an hour—have proved the worth of the B-58 Hustler bomber's new "2-component" bomb and fuel pod.

Tests have been conducted successfully at Nevada and New Mexico missile ranges by Convair and the Air Force. Flights were from Kirtland Air Force Base, N. Mex. Drops have been made at altitudes ranging from 1,000 feet to more than 40,000 feet, at both subsonic and supersonic speeds.

Shaped more like a slim fighter than a bomber, the Hustler was designed to carry its nuclear bomb and part of its fuel externally in a streamlined droppable pod slung beneath the fuselage. Bombers now in service with the Strategic Air Command have this single pod. (See photo on page 224.)

The newer model consists of a small bomb pod, nested into a recess in the top of a large fuel pod. When the external fuel is expended, the pilot can shed the lower component and fly on to the target, completing the mission with fuel from wing tanks.

Technical Research Ship

The technical research ship OXFORD (AG-159) was commissioned recently at the New York Naval Shipyard. Although the first of this type to be specifically outfitted for research operations, OXFORD joins a growing list of merchant-type ships converted by the U. S. Navy for specialized duties afloat which do not require the costly speed and armament of a fleet-type ship. Ships in this class include U.S.S. COMPASS ISLAND, missile-range instrumentation ships and the AGR's (ocean radar station ships).

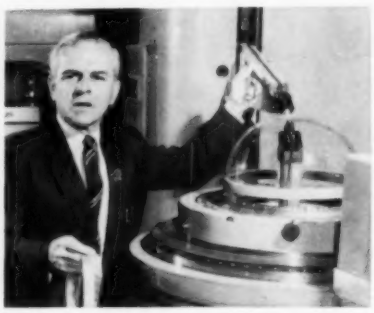
The OXFORD has been primarily equipped to conduct research in the reception of electromagnetic propagations. As modern communications methods become worldwide in scope and employ satellites, microwave links, and tropospheric-scatter techniques, many phenomena are encountered which are not consistent with current research data.

By equipping the OXFORD with the latest antenna systems and measuring devices the Navy will have a highly sophisticated and mobile station which can be sent to various parts of the world to participate in research and evaluation experiments. Because of immediate or potential military application of these equipments, most of OXFORD's work will be classified.

In addition to research in electromagnetic reception, the vessel also will be equipped to conduct hydrographic and oceanographic research operations. OXFORD was the former S.S. SAMUEL R. AITKEN, a Liberty ship completed just after World War II.

Tape-Controlled Gage

Tape-controlled precision measurement for automating a critical phase of the Nation's missile and space program has been developed by the Sheffield Corporation, Dayton, Ohio, resulting in a 16-ton system



Sheffield Board Chairman Louis Polk examines new tape-controlled gage.

that is "commanded" by a roll of punched tape and can complete in two hours almost 1,000 precise measurements of a critical component such as a missile nose cone.

The gage is so sensitive it can automatically detect a change as small as 10-millionths of an inch in the size of relatively large internal and external measurements. It is capable of inside, outside, and thickness measurements of parts of any shape and can quickly locate an almost microscopic spot where a missile part might be out of tolerance. The system simultaneously measures the inside and outside dimensions or the contour of a part, determines wall thickness, and prints the results as well as providing visual readout.

Typhon Missile System

The Navy has selected the Bendix Corporation to develop the long-range Typhon missile. The Typhon weapon system will consist of shipboard control units, a radar, launching systems, and missiles.

The Applied Physics Laboratory of the Johns Hopkins University conducted preliminary design work for the Typhon missile and will have technical direction of its development. The shipboard electronics, including radar and weapon-control equipment, has been under development for more than a year by the Westinghouse Electric Corporation in Baltimore.

When developed, the Typhon is expected to provide the fleet with a greatly improved antiair warfare capability plus an offensive capability for engaging enemy fleet units. The system should greatly extend the range and improve the accuracy, target-handling capacity, and quick reaction capability of future guided-missile warships. When launched from guided-missile cruisers, Typhon missiles will be able to intercept both enemy aircraft and missiles at great ranges from primary fleet targets.

Malleable Iron Shell

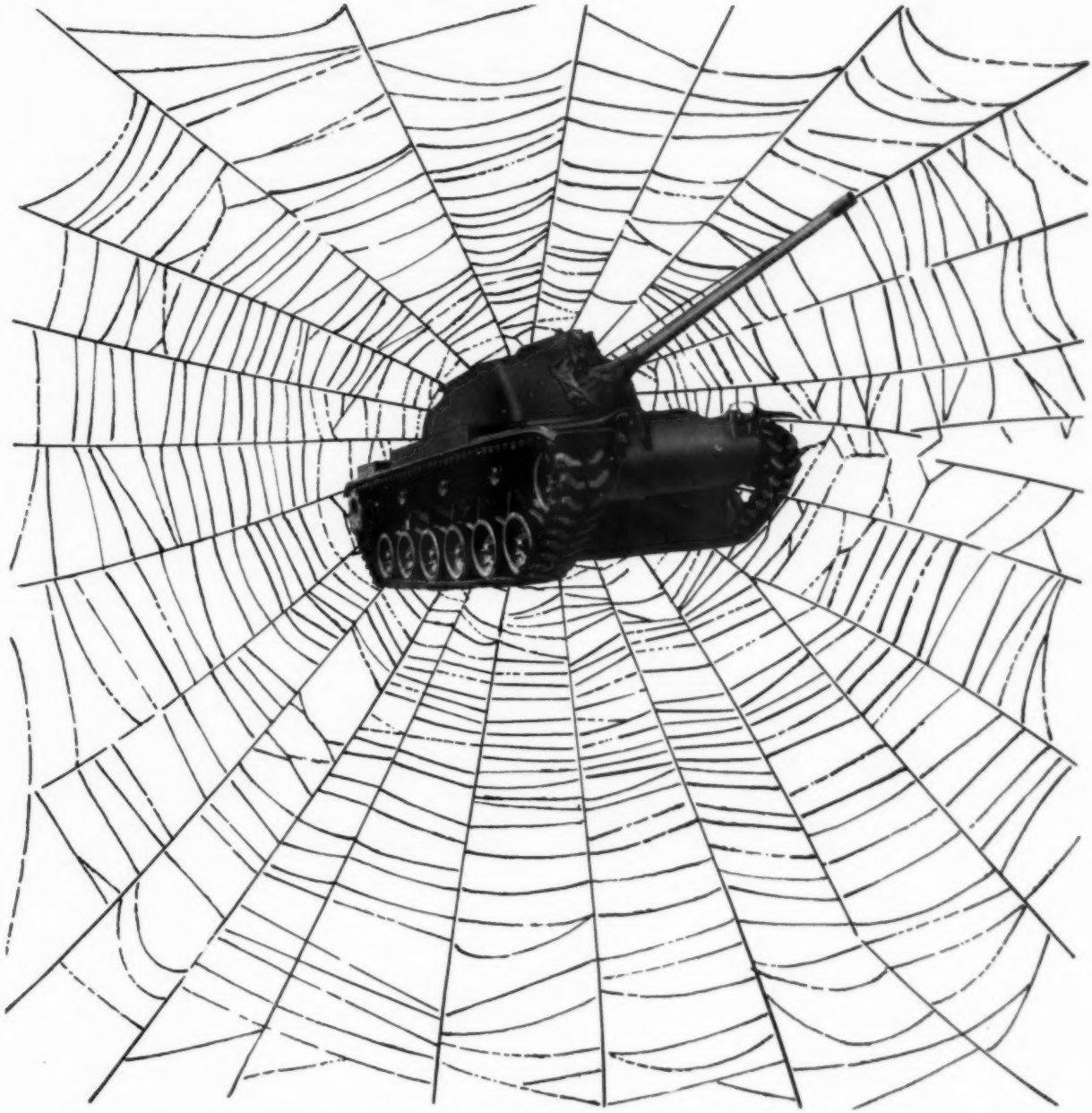
The Army Ordnance Special Weapons-Ammunition Command disclosed recently that a revolutionary method has been developed for the casting of artillery and mortar shell for the U. S. Army. The new process permits the casting of shell from malleable iron instead of forged steel.

A contract for the production of 173,800 rounds of 81-mm. mortar shell has been awarded to the Albion Malleable Iron Company, developers of the process. In addition to more effective fragmentation, the new process permits production with a noncritical material, thus making more steel available for other defense work.

To assure complete safety of the shell, a specially designed ultrasonic inspection device which detects and rejects unsound castings has been developed by Albion and Sperry-Rand Corporation. The lack of a reliable and rapid method of inspection previously had been a major stumbling block in efforts to develop an efficient production process.

Compact Accelerometer

A highly accurate space-guidance instrument that can measure forces as minute as one-millionth the pull of gravity from any direction has been developed by Sperry Gyroscope Company. Key to the operation of the most advanced inertial guidance systems, the device is an integrated accelerometer responsible for precisely recording an unlimited range of velocity changes that may



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occur during flight. Should an acceleration force equivalent to one-millionth the pull of gravity go undetected, a space vehicle whose destination is thousands of miles from earth could drift hundreds of miles off course.

In addition to detecting minute forces, the revolutionary device also can measure forces as great as thirty times the pull of gravity. Weighing slightly over two pounds, the compact accelerometer can replace a trio of single-direction accelerometers that have a combined weight and space requirement three times that of the newly developed instrument.

The new device also can eliminate some twenty pounds of extra equipment presently needed to integrate the information supplied by the three conventional accelerometers. Engineers achieved the compact design by developing one lightweight frame that incorporates three separate accelerometer axes. Together they measure forces in the three dimensions of space.

Air Track Vehicle

Experiments will be started soon on a revolutionary Army vehicle designed to travel on water, hard surface, snow, mud, or tundra. The projected vehicle would operate on a continuous track of rubber-impregnated cells filled with low-pressure air, giving the vehicle high flotation capability and permitting it to ride over soft terrain or water. The machine, which probably will resemble a tank, would have self-cleaning tracks, with air blowing away mud, dust, or snow.

Development of the vehicle, called Pat, for plenum air track, will provide a preliminary investigation of the new concept in transportation. Plenum is an air-supply chamber which can be furnished with air automatically if pressure is lost. The cells would be self-sealing if punctured.

Plans call for the Pat to travel about 10 miles an hour on water and 50 miles an hour on highways. The speed on water would be twice that of present amphibians.

High-Speed Camera

The Naval Ordnance Laboratory has developed for the Atomic Energy Commission a motion-picture camera for filming and timing high-speed action simultaneously in color and black and white. Capable of exposing film at 1/50-millionth of one second without losing picture quality, the camera uses a constantly open lens which receives the image and passes it to a revolving mirror. After bouncing the image among other mirrors and through several lenses, the same revolving mirror then literally "sprays" the image onto a motion-picture film strip.

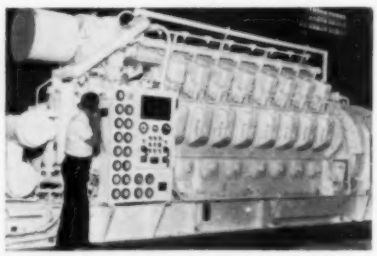
In timing high-speed motion, such as a speeding bullet or an exploding block of TNT, the camera films the action with such accuracy that the speeding image is captured in a series of perfect, unblurred pictures.

The new camera, recording single-frame action at 20-billionths of a second while taking one million frames a second, is 15 times faster than the high-speed cameras currently in use which take 300-billionths of a second to record the action in one frame. The ultra high-speed camera gives additional precision to the measurement of extremely fast motion found in ballistics, explosives, and aerodynamics.

The camera's extremely low exposure time and twin-exposure feature are attributed to the first known application of the focal-plane-shutter principle in a motion-picture camera.

Precise Diesel Power

Seven diesel-electric generating units will provide "precise power" for the Army's Advanced Research Projects Agency ballistic missile defense research facility on Kwajalein Atoll in the Pacific. Alco Products, Inc., manufactured these



The 16-cylinder, 2,110-horsepower diesel.

units which will provide power with extremely accurate control of voltage and frequency at the power source. They will maintain steady-state voltage to within one-half of one per cent and steady-state frequency to within one-quarter of one per cent. The units will supply 10,500 kilowatts of power for Project Press (Pacific Range electromagnetic signature study), on Roi-Namur Island. The facility is part of ARPA's ballistic missile defense research program, Defender, and will be used with other installations to conduct tests in missile phenomena and discrimination techniques by observing missiles launched on the Pacific Missile Range.

Each of the Alco diesel-electric generating units has a 16-cylinder, 2,110-horsepower diesel engine which will drive a 1,500-kilowatt Westinghouse generator at 900 revolutions a minute. Each engine will be capable of a ten per cent overload if an emergency should require it.

New Tool Steel

To help solve one of the critical problems of space-age metallurgy—the difficulty of machining new superstrength metals developed for missiles, jet aircraft, and satellites—Continental Copper & Steel Industries, Inc., has developed and started commercial production of a new type of high-speed alloy tool steel that is said to approach the hardness of a diamond. It will cut virtually all other known metals or alloys and, in extensive tests, has kept its cutting edge up to ten times as long as previous standard tool steels.

A special composition of steel, containing chromium, vanadium, tungsten, molybdenum, and cobalt, plus a relatively small percentage (1.15) of carbon, the new alloy can be heat-treated and ground by conventional procedures. It has a Rockwell hardness of up to 70C, the highest ever achieved for any wrought high-speed tool steel.

Thin-Film Transistor

An ultraminiature experimental transistor, so small that as many as 20,000 can fit on a postage stamp, has been developed by the Radio Corporation of America. The transistor is made by depositing thin films by evaporation on an insulating base and is capable of shrinking the basic circuitry of a computer to the size of a book page.

The new device, it is claimed, may open the way to new ultraminiature mass-production transistor circuits for many applications, especially in electronic computers and perhaps ultimately in other equipment such as thin-screen wall-type television receivers.

In making the transistors, an evaporation process is used to deposit successive thin layers of cadmium sulfide and metal on a glass plate, creating a device that is only a few ten-thousandths of an inch thick. In the evaporation process, the cadmium-sulfide crystals and the metal are heated in successive steps in a vacuum, turning to vapor that is collected by condensation on the glass plate in the same manner as steam condenses in a film on a cooler surface held over boiling water.

By using a special mask to cover portions of the plate during the process, the metal layers are deposited in a pattern that forms the electrical contacts needed to operate the transistor.

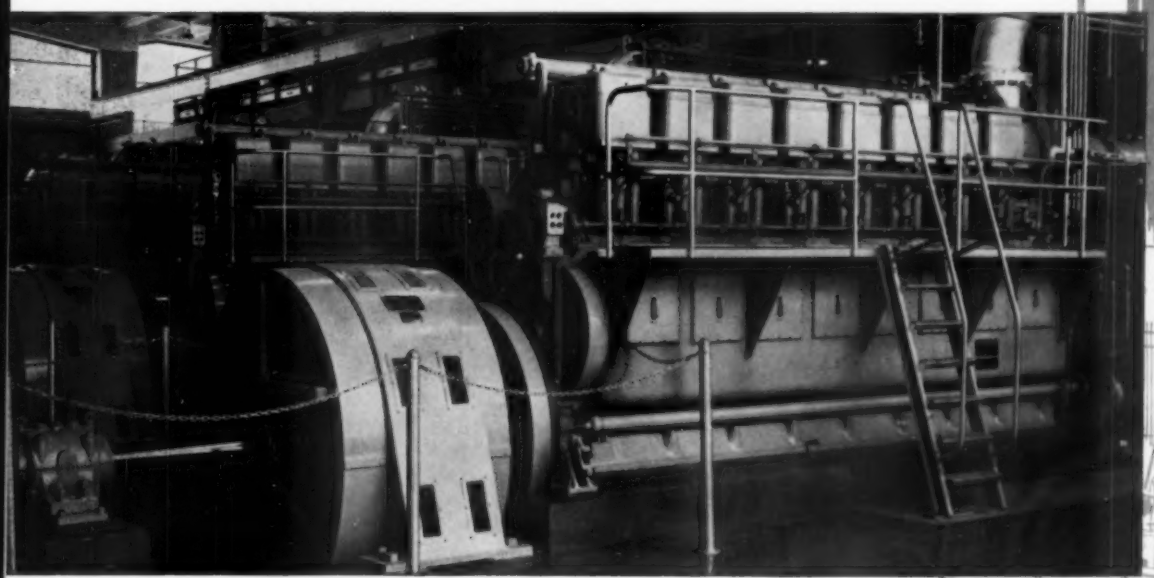
The completed transistor is not only very tiny, but it also incorporates an important operating feature not now used in commercial transistors. In conventional transistors having comparable functions, electrons flow more or less freely through the semiconductor material between two of the contacts, and the third element provides control by reducing the flow in varying degrees. The operating principle of the experimental thin-film transistor is exactly opposite—the insulating properties of the cadmium sulfide hamper the flow of electrons between two electrodes, and the third element provides control by increasing the flow in varying degrees.

ATLAS MISSILE COMPLEX

unfailing power supply assured with 6 NORDBERG DIESELS

The locale . . . an isolated point of land jutting into the Pacific Ocean near Los Angeles. Sprinkled through this brush-covered area is the incongruous evidence of the free world's first operating and training base for both intercontinental (ICBM) and intermediate range (IRBM) ballistic missiles. Suddenly, the area has sprouted towering gantries, huge concrete slabs, a busy air field, shops and offices, homes and barracks. This is Vandenberg Air Force Base, which has mushroomed into a populated, multi-billion-dollar aero-space age defense establishment.

The major mission of Vandenberg is to maintain an operational status with ICBM's. The base must be ready at a moment's notice to blast off its "birds" without fail. Vandenberg also serves as a training site for SAC ICBM crews to be deployed at bases throughout the country.



To insure an unfailing power supply, the Atlas Complex includes a modern power plant, comprised of six husky Nordberg turbocharged diesels rated 1344 hp at a conservative 450 rpm, giving the plant a total capacity of 8,064 hp. Each engine drives a 956 kw generator, and the total capacity of over 5700 kw gives the plant plenty of reserve capacity . . . a Nordberg diesel-electric generating plant that assures the world that no electric power failure will delay the gigantic Atlas guided missiles if they must soar into space in any emergency.

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P 660-R2

MISSILE SUPPORT EQUIPMENT

Robert S. Sartoris

Missile Transport.—To save time in moving huge missiles across country to their launching pads, NASA is studying the possibility of modifying a C-133 turboprop transport. One proposal under discussion involves packaging the missile in a capsule and carrying it on top of the C-133. The package would be designed for a multipurpose unit to carry other materials besides missiles.

Problems faced in the proposal include redesign of the tail structure, with modifications ranging from adding a few small outer fins for small missile capsule usage to a complete redesign of the tail to include dual fins and rudders for larger capsules.

From wind-tunnel tests NASA believes the idea to be practical, and indications are that, if the Government gives a go-ahead, a fully modified aircraft could be ready within a year.

Value of the airlift would be the savings of delivery time and wear and tear. A shipment of a large missile such as is on the books for future programs now would require the use of combined barge and shipboard transport for, say, delivery from the West Coast to Canaveral. This would take some twenty-four days, going through the Panama Canal, and would require considerable handling of the delicate birds. Air shipment, on the other hand, would require a minimum of handling and reduce travel time to half a day.

According to Marshall Space Flight Center Director Wernher von Braun, who is already faced with these transport problems in connection with the giant Saturn rocket program, the idea has considerable merit, and he is looking forward to further information. If it proves practical, the C-133 idea would be better than the dirigibles and gliders previously proposed, he said.

Air Trailer.—Another concept proposed to NASA for missile transport is an air trailer, a glider-type unit coupled to its tow plane at all times by a semi-rigid towbar. Suggested tow plane is the Air Force C-130A. One model of the concept, now on the drawing boards, is 160 feet long and has a 210-foot wingspan. It could carry loads 24 feet in diameter, 90 feet long, and up to 50 tons in weight.

Mr. Sartoris is on the staff of Boeing Company, Seattle, Wash.

Missile Site Communications.—Communications between launch sites at widespread complexes under construction has been a major problem to missile-using agencies. At the 8,000-square-mile Fairchild Air Force Base in Washington, the separate sites are linked to an underground control center with a toughened microwave system capable of withstanding blast pressures up to 25 p.s.i.

The equipment, to ensure the Strategic Air Command of positive launch control despite malfunction, sabotage, or blast damage, has automatic trouble-finding and rerouting provisions. Most of the equipment, except antenna dishes, is located underground in concrete-steel bunkers twenty feet below the surface. Antennas are mounted on concrete pillars and enclosed by one-inch-thick plastic domes.

The microwave system provides several voice channels to and between each launch site, as well as command and control circuits that keep the control center advised as to the ready status of each site.

Semihardened Titan II bases use a different form of communication. For communications with underground launch silos the Air Force will use UHF or VHF radio. Although this system lacks the privacy of a microwave system, it has the advantage of using more compact antennas that can be protected more easily from attack.

Deeply buried Minuteman silos will use still another and far more unique system. The radio equipment for command and control of these sites will use the new earth-current communications technique for added security and relative immunity to jamming. In this type of system the earth itself is used to channel a signal, either through its surface or the geological structures far below the surface.

New Minuteman Sites.—The Air Force has chosen two more sites for installation of Minuteman intercontinental ballistic missiles, raising to four the number of bases selected for the solid-propellant war rocket. Bases for 150 missiles each will be located at Whitman, Mo., and Minot, N. Dak. The sites for the six 50-missile squadrons will round out the currently planned force of 600 Minutemen. There are already 150 going in at Malmstrom AFB, Mont., and another 150 at Ellsworth, S. Dak.

All bases will have underground launching silos with blast-resistant doors or covers. The Air Force meanwhile is considering other sites for Minuteman in view of cancellation of the last two squadrons of liquid-fueled Titan II missiles and deferment of operational rail-mounted Minuteman missiles.

Trailers for Missilemen.—A new type of missile support equipment is being added to missile bases in increasing numbers—mobile homes and trailer units for the thousands of technicians involved in site construction and operation. For example, the Malmstrom Minuteman site will require the services of more than 1,500 persons as the assembly and checkout program reaches its peak late next year.

Since many launch sites are located in remote regions or sparsely populated areas in order to reduce danger to near-by inhabitants, housing has become a serious problem. As a result, whole villages of trailers, mobile home units, and knockdown buildings for schools and stores are being collected and readied for occupancy by technicians and their displaced families.

Noise.—An intensive program of research and analysis into the problem of acoustic vibration resulting from the launch of a Titan ICBM from an underground silo was successfully completed when the big bird was launched from its silo launch test facility at Vandenberg AFB. The successful launch confirmed solution to the problems presented by the roar of Titan's 300,000-pound-thrust booster engines when fired from within below-ground launching facilities.

If uncontrolled, noise generated by missile engines could literally shake the missile apart during the several seconds required for it to rise out of the silo.

Analysis of the acoustic environment created during firing, confirmed by a series of scale-model tests, determined that noise problems could be solved by lining the launch and exhaust ducts of the silo with sound-absorbing acoustical insulation.

For the test a 3-foot-thick fiberglass acoustical liner was attached to the walls of the 28-foot-wide launch duct. A heat-resistant acoustical material was also installed throughout the two exhaust ducts on each side of the central duct.

The success of the launch tests was such that plans for additional test launchings may now be canceled.

men at work on a new approach to the stars

As principal instrumentation contractor for Project Rover, EG&G is already at grips with the central problems of nuclear propulsion for deep outer space exploration. A control, instrumentation and data acquisition system designed and operated by EG&G is of basic importance in the full-scale testing of Rover's KIWI prototype engines, designed by the Los Alamos Scientific Laboratory. The EG&G system is being effectively applied to the solution of problems of heat transfer, neutronics, fluid dynamics and general control.

EG&G instrumentation is also at work in the application of nuclear energy to industrial uses (Gnome) and in the international program for detection of nuclear explosions (Vela). In oceanography, EG&G equipment is probing the ultimate ocean depths. An informative brochure which describes the breadth and depth of EG&G's capabilities is available on request.

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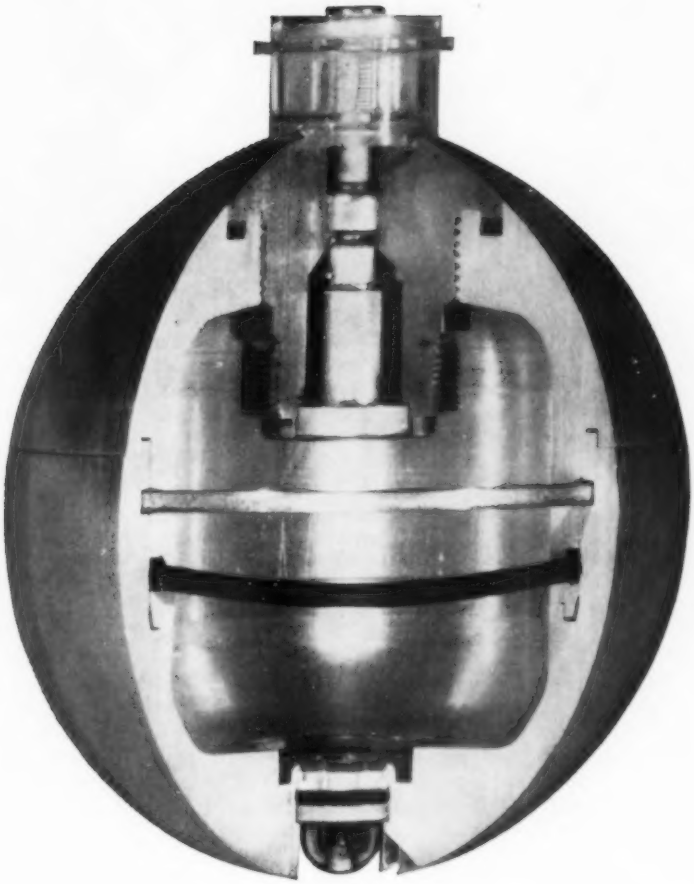

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UNDERWATER ORDNANCE

P. Eleson

Oceanography and, ultimately, underwater ordnance will suffer unless action is taken promptly to assign radio frequencies for the collection of remotely gathered data on the oceans and the air-sea interface. Proportionally, very little is known about the ocean (only about two per cent of the ocean's bottom topography is adequately mapped, for example). To gain a truly operational familiarity with this environment and to maintain our weapons systems lead over the Russians, the U.S. is preparing an ambitious program of oceanographic exploration. This will be based on a substantial increase in the number of American oceanographic ships in service and, more importantly, a worldwide complex of manned and unmanned data-gathering buoys.

These devices will be quite self-sufficient and, as a result, will not possess the radio power necessary to transmit their findings to distant shore stations. Data stored on continuous tape will have to be "milked" from the unmanned buoys at regular intervals—by ships, planes, or satellites (it hasn't been determined which yet). The monitoring vehicle, when within range, will command the buoy to disgorge its data in a burst of high-speed telemetry.

Problem is that the available radio frequencies in the telemetry bands are already virtually saturated by National Aeronautics and Space Administration, military, and commercial assignments. Though shy on publicity to date, this is a problem about which oceanographers are seriously concerned, and one about which Washington in general, and the Federal Communications Commission in particular, should start thinking.

Vehicles to "milk" unmanned oceanographic buoys of their stored data will probably be satellites or aircraft. Repeater-type communications satellites could collect data as they pass overhead and rebroadcast the information in real time to waiting shore stations or strategically located ships. Another suggestion is that the erstwhile U-2 would do a good job both scientifically and politically by being put to this peaceful scientific task. Odds are against surface ships being given this job since there would have to be too many of them. Purpose of this type of oceanographic exploration is to acquire a continuous record. Thus, the data will have to be extracted before on-board tape capacity is exhausted.

Mr. Eleson has been a student in physics and has long held an interest in oceanography. He is an experienced author on technical subjects both here and abroad and is at present professionally interested in the field of underwater ordnance.

ALBACORE, which proved out the modern high-speed underwater hull design, continues to contribute more than its share to advancing the state of the submarine art. According to Rear Adm. Ralph K. James, U.S.N., Chief of the Bureau of Ships, an extensive investigation into submarine maneuverability, dynamic stability, increased speed, and quieter running is being conducted with ALBACORE as the main research tool. Specific attention is being paid to control-surface configurations, contrarotating propellers, and new high-capacity batteries.

Deep-diving counterpart of ALBACORE is AGSS (experimental deep-diving submarine) which will conduct research into all aspects of the deep-depth operational submarine of the 1970's—including advanced weapons evaluation, deep-sea tactics, acoustic and oceanographic research. It will also engage in war games to familiarize present ASW crews with what they will have to face when the submarine becomes even more of a 3-D device than it is today. AGSS' pressure hull is of novel design—a constant-diameter cylinder eighteen feet in diameter, internally framed, and closed with hemispherical heads.

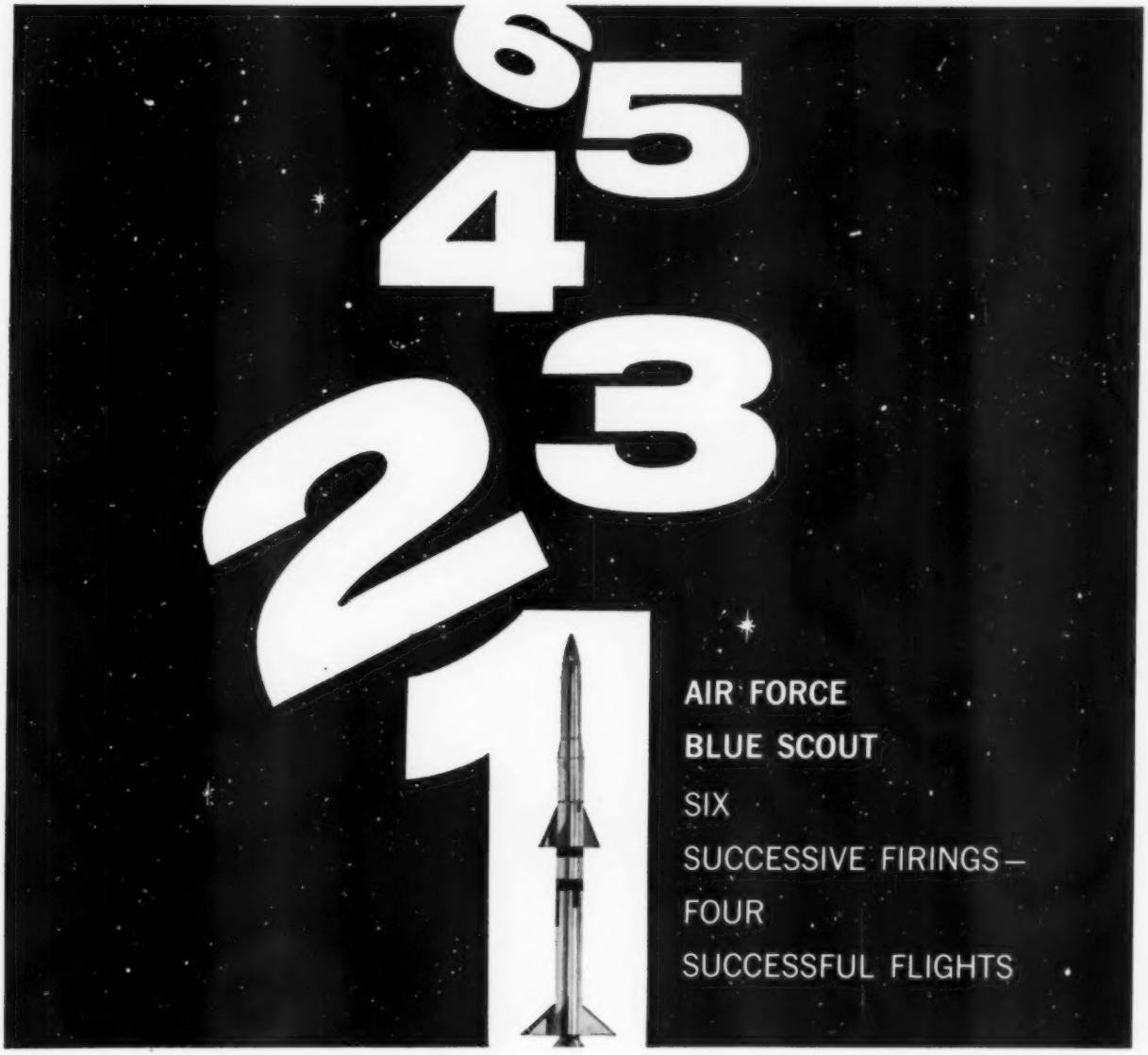
Despite present efforts to develop an HY-150 steel (150,000 p.s.i. tensile strength compared with present 80,000 p.s.i.) for submarine pressure hulls, there's increasing conviction that the deep-diving submarine hull of tomorrow will rely more on nonmetallic composites than it will on steel—or even titanium, aluminum, or beryllium. Particular interest is being displayed in epoxy resins reenforced with standard E glass filaments. Capabilities already exist for winding cylinders in excess of fourteen feet in diameter. Unknowns are resin creep rates and minimum fatigue failure lives of such structures in the anticipated environment. Slight tendency of some of these resins to absorb water is not considered a problem, though this, too, warrants investigation.

Some of the gasoline in the TRIESTE's buoyancy tanks may be replaced by lithium metal. The Navy is concerned over the fire hazard presented by the deep-diving craft while on the surface. Contracts already have been placed to provide a plastic-reenforced glass container for the lithium to isolate it from any contact with seawater—with which it is violently reactive.

Recently released testimony by Vice Adm. Hyman G. Rickover and Rear Adm. W. F. Raborn before the Joint Committee on Atomic Energy (taken, incidentally, 400 feet below the surface, 55 nautical miles from New London aboard the U.S.S. GEORGE WASHINGTON) reports marked improvements in submarine nuclear propulsion and at the same time reduced costs. The original reactor core in the NAUTILUS was good for 60,000 miles; the third one, recently installed, was 20 per cent cheaper than the first and is good for 120,000 miles. The original SKIPJACK core cost $4.5-million; the latest one costs half as much and has a much longer life. Total cost of nuclear propulsion plants for either Polaris or attack submarines is $12 to $13 million, including fuel.

Other facts from this submerged testimony include: Operational date for the 1,500-mile A-2 Polaris—March 1962 . . . Efforts are under way to develop a method for refueling nuclear submarines that doesn't involve cutting a hole in the hull . . . There's still a lot of serious talk about installing the Polaris missile on surface ships and in various types of ground bases.

Ambient radioactivity in the ocean can now be measured by DUNC—a deep underwater nuclear counting device so sensitive it can detect one atom of radium in a billion billion molecules of water. Approximately six inches in diameter by three feet long, the device was developed by the Nuclear Physics Div. of the U. S. Naval Ordnance Laboratory, White Oak, Md. Main sources of oceanic radiation are potassium 40 in solution and com-



[1] CAPE CANAVERAL, Fla., Sept. 21, 1960--United States Air Force Officers and Airmen of the Air Force Ballistic Missile Division (ARDC) today successfully launched a four stage solid fuel Blue Scout Junior research rocket high over the Atlantic Missile Range. [2] CAPE CANAVERAL, Fla., Nov. 8, 1960--The Air Force Ballistic Missile Division today test launched for the second time a four stage, solid fuel, Blue Scout Junior research rocket. Today's firing is part of the Air Force program to launch vitally needed scientific space packages on a regularly scheduled basis. [3] CAPE CANAVERAL, Fla., Jan. 7, 1961--The Air Force today launched the largest solid fueled Ballistic vehicle to date at the Atlantic Missile Range. Carried for the first time aboard the Blue Scout test vehicle was a guidance system operative during all three stages. [4] CAPE CANAVERAL, Fla., Mar. 3, 1961--An Air Force Blue Scout rocket today lofted a 172 pound payload approximately 1,580 statute miles into space. The payload was designed to make detailed radiation measurements as it travelled through the lower edges of the Van Allen Belt. [5] CAPE CANAVERAL, Fla., April 12, 1961--Development Flight No. 5 of the Blue Scout was successfully launched today, the Air Force announced. Carrying seven experiments, three bursts of seven flares were fired and tracked by a camera system from Cape Canaveral. [6] CAPE CANAVERAL, Fla., May 10, 1961--A range safety officer made a $500,000 decision yesterday and ordered destruction of a Blue Scout Junior rocket seconds after it was launched. Yesterday's failure was only the second for the Blue Scout in six firings.

The reliability of the Air Force Blue Scout is one of the highest in the industry. Aeronutronic is system engineer, payload and test contractor on Blue Scout. Additional information is available upon request.

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pounds of radium and thorium which tend to concentrate in bottom sediments. Interest in determining ambient radiation level stems from desire to use tracers in studies of ocean currents and concern over radioactive waste disposal in the ocean's depths.

Closed-circuit television for observations to depths of 5,000 feet or more has been developed by Oceanographic Engineering, Inc., La Jolla, Calif. Completely transistorized, the unit is the most compact on the market today. For example, the camera, including image tube, automatic aperture setting, remote focusing system, and pressure vessel totals only 2.5 inches in diameter and less than 30 inches long. Seven-inch monitoring screen and control panel plus associated circuitry are smaller than and weigh less than an unabridged dictionary. Picture quality is excellent.

The ocean around Bermuda is going to be a mighty noisy place as Project Artemis gets under way. Biggest underwater noisemaker ever built has been installed on the former Navy tanker U.S.N.S. MISSION CAPISTRANO. This high-powered transducer weighs "hundreds of tons and is five stories high." Its power output would "furnish lights for a town of 50,000." The device will transmit signals which Artemis' complex of underwater hydrophones will detect. Signals received will then be processed through Argus Island, a tower installed on an underwater mountaintop thirty miles southwest of Bermuda. Ultimate objective of all this is, among other things, development of an underwater DEW Line for submarine detection. Prime contractor for Artemis is Columbia University's Hudson Laboratories. Over thirty university, government, and industrial laboratories are participating.

The difference between submarines and whales (which give identical responses to active sonar) can now be determined acoustically as a result of work done by the U. S. Navy Research Laboratory and the Electronic Systems Division of Telecomputing Corporation. This is an important contribution to ASW, since nearly one hundred whales are known to have been sunk as submarines in the Second World War.

The homing pigeon is back in the navigation business again, along with a number of other animals. Office of Naval Research has developed a method for continuous and accurate tracking of homing pigeons as part of a program to try to discover just how they navigate so unerringly over unfamiliar territory. System consists of one milliwatt transistorized transmitter powered by three mercury button cells attached to the pigeon's back and trailing a 40-inch dipole antenna. Contractor to ONR is American Electronic Laboratories, Philadelphia, Pa. Signals are received by two units sporting narrow bandwidth, high-gain Yagi array antennas. Course is computed by triangulation.

Similar plans are afoot to instrument marine animals such as whales, porpoises, sharks, and turtles. Proposal is to mount similar radio transmitters on their backs with flexible whip antennas which will transmit when the creature surfaces.

Passive underwater submarine detection based upon a system of permanently installed turbulence meters is being proposed by Aerojet-General Corporation's newly established Oceanics Division. The company claims impressive sensitivity at lag-time detection of submarines passing by at considerable distances. First requirement, however, would be an extensive study of the ocean's ambient turbulence. This company, incidentally, has recently bought 45 per cent of Global Marine Exploration Company and has broken its ASW division into two separate divisions—oceanic and torpedo.

Upside-down depth bomb is Navy's latest twist in undersea weapons. Still only in the investigatory stages, this device with high positive buoyancy would be released from a submarine for attack on surface ships or to become a surface-based antiaircraft platform. Reports are that positive buoyancy is such that speeds up to 60 knots are obtained in the vertical up direction, with no other propulsive force. Importantly, such a weapon would have the advantage of being absolutely silent. This concept was first proposed by Robert Taggart (Project Mohole) in 1957 in an article written for a trade publication.

Antiaircraft version would be a device released by deeply submerged submarine which would rise to surface, detect and track aircraft, and then attack with missiles. As we said, these are only proposals now. Status of work is that of studying mechanics and hydrodynamic efficiencies of various designs of the "buoyant ballistic inertial missile."

An indoor ocean is the latest in developmental and test facilities to be added to the capabilities of the David Taylor Model Basin, near Washington, D. C. Dedicated on June 20th were the maneuvering and seakeeping facilities housed under a 5-acre building. Included are a 240- by 360-foot rectangular basin with depths ranging from 20 to 35 feet, with a 15-ton, 20-knot towing carriage, and wave-making facilities capable of duplicating sea state 8-9. This is the largest facility in the world capable of recreating actual ocean conditions. In addition there is a 260-foot-diameter, 21-foot-deep rotating-arm basin capable of attaining a 30-knot speed at the 120-foot test radius.

Dash (drone antisubmarine helicopter) produced by Gyrodyne Company of America, St. James, N. Y., has now completed over thirty-eight flights, including twenty-two missions by one DSN-1 drone from the U.S.S. HAZELWOOD. Dash extends destroyer antisubmarine attack range more closely to that of the DD's detection equipment. The unmanned helicopter can be sent out from its mother ship, ordered to attack, and then recalled for further missions. Present models are operating with 72-horsepower Porsche reciprocating engines.

From Davy Jones' Locker

Problem in high-speed submarines: With 100-knot hydrofoils, GEM's, and other high-speed hunt-and-kill surface craft a virtual certainty in the 1965-1970 period, Navy submariners are wondering what they can do to up the submarine's submerged speed to something in excess of that. Right now, there isn't a surface ship that can catch or outrun a nuclear submarine (whose speeds, the Commerce Department indicates, range around 35 knots). Advent of hydrofoils, etc., will reverse this situation. The Navy wants to make certain its undersea craft maintain every possible advantage. Search involves new approaches to propulsion, hydrodynamic innovations, etc. In all cases minimum noise is a requirement.

Problem in weapons: As the speeds of vehicles (both surface and submerged) go up, so must the speeds of weapons—which should maintain at least a 33 per cent advantage over their targets. As in the case of submarines, increased weapon speeds raise noise problems—particularly troublesome where a weapon's own self-noise may obviate effectiveness of its acoustic homing guidance.

Problem in versatility: Navy right now is trying to determine just what the submarine weapon will look like in 1970. Strongly favored is a 100-knot (or better) craft with a depth capability of between 4,000 and 6,000 feet. Possible armament for this craft might be a family of weapons that would give it maximum combat versatility. For example, Navy is interested in proposals for a group of weapons firing through a torpedo tube (probably in excess of 21 inches in diameter) that would be able to: Provide strategic bombardment at a 1,500-mile range; attack surface ships; attack other submarines; plant mines; attack aircraft; and provide close-in tactical support for amphibious landings.

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PUTTING IDEAS TO WORK FOR NATIONAL DEFENSE

ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Nuclear Rockets

A Nuclear Vehicle Projects Office has been established at NASA's Marshall Space Flight Center to supervise and coordinate development of high-thrust nuclear rocket stages for future Saturn and subsequent vehicle systems. Current program is the Rift (reactor in-flight tests) vehicle, proposed to be flight-tested as the second-stage Saturn C-3 booster in 1966-1967.

Rift will be powered by a nuclear engine now being developed under Project Rover and known as Nerva (nuclear engine for rocket vehicle application). The reactor used by Nerva will be follow-on to Kiwi-B reactor, presently under test at Los Alamos Scientific Laboratory in Nevada. Hydrogen has been identified as the propellant to be used in future nuclear-powered rockets in the U. S. program.

According to AEC, the major problem of the atomic rocket lies in the materials which can withstand the high temperatures needed to provide the rocket performance increases in the 1970's. Another big problem is thermal shock, especially on start and on shutdown.

Liquid Rockets

Offshore launch for Nova-type vehicles is being proposed. Launch is being planned for a site about fifteen miles out in the Atlantic Ocean off Cape Canaveral, Fla. Explosive and acoustics hazards are reasons for the needed safety distance. One configuration, for example, would be 6-staged and would total 396 feet in length, have a booster diameter of 65 feet and a last-stage diameter of 15 feet.

Total propellant load would be over 9 million pounds and the first-stage thrust of 12 million pounds would be developed by a cluster of 8 F-1 engines (1.5 million pounds' thrust each). NASA has outlined two other Nova configurations. A 4-stage and a 5-stage version have been proposed.

Liquid Nova hinges on the F-1 engine which will complete its flight-rating tests in 1963. The liquid oxygen-RP-1 engines are currently under test and equipment is being fabricated. Full power tests of up to twenty seconds' burning time are slated initially. Full duration, however, is 150 seconds.

Meanwhile, the J-2 (liquid oxygen-liquid hydrogen) engine is nearing. Early in 1963 the engine should undergo preliminary flight-rating tests. Qualification tests are slated for 1964. The J-2 engine develops 200,000 pounds of thrust and is to be used in clusters for upper stages of Nova.

A typical Nova configuration would use 8 F-1 engines for the first stage or a total of 12 million pounds of thrust; the second stage would use 2 F-1 engines for 3 million pounds' thrust; third stage would use 4 J-2 engines for 800,000 pounds of thrust; fourth stage consists of 6 RL-10 engines (liquid oxygen-liquid hydrogen of 15,000 pounds' thrust each) for a total of 90,000 pounds of thrust; and a fifth stage of two RL-10 engines for a total of 30,000 pounds' thrust.

Liquid launch vehicles currently being studied by the Air Force for the Dyna-Soar program include several mixed systems. One system would use Titan II with a cluster of solid rockets around the booster; the solid engines would ignite first, followed by liquid operation in the air. Titan II might be coupled with the Saturn S-IV stage using liquid hydrogen.

A J-2 engine of 200,000 pounds' thrust might be mated with the Titan II. Also, use of the Saturn 3-stage C-1 vehicle is being studied. The program could call for an early glider flight at the end of 1962 or early 1963. Five vehicles are said to be planned for the first phase of the boost-glide program which involves suborbital flights.

The Saturn program is to get a 6-to-9-month speed-up by NASA. Final choice for the builder of the 800,000-pound-thrust S-II engine is due soon. S-I will soon be farmed out to production and the S-IV stage will use six RL-10 engines. The Saturn C-2 may be used for unmanned missions and possibly could be used for Apollo circumlunar flights.

Saturn C-3 will use two F-1 engines of 1.5 million pounds' thrust and could be used for all lunar missions with the exception of manned lunar landings. Saturn S-IV facilities are nearing completion at Sacramento, Calif. Thor facilities are being modified for the forthcoming tests which will use six LR-115 liquid oxygen-liquid hydrogen engines. Ten vehicles are being planned.

Solid Rockets

The Nova-class solid rocket is to be developed by the Air Force under NASA specifications. Solid Nova will be a parallel program to the liquid version. The solid booster would be able to impart escape velocity to 150,000 pounds. Two configurations are visualized at the present time.

The most popular one would be made up of three stages. The first stage would develop 20 million pounds of thrust and weigh 10 million pounds at launch. A cluster technique would be used and would contain eight solid rockets of 1.25 million pounds' thrust each. Each solid rocket would be 120 feet long and have a diameter of 13 feet. Second and third stages would be clusters of liquid hydrogen-liquid oxygen engines of 200,000 pounds' thrust. Total length of this design would be 360 feet, and the maximum booster diameter would be only 45 feet as compared with the 65 feet for the liquid version.

A 4-stage solid design is also seen. It would use solid rockets on the second as well as first stage. Total length would be 410 feet. The Air Force will spend $62 million on the solid Nova in the fiscal year 1962 and the total program cost may amount to $500 billion.

A half-million-pound-thrust solid rocket already has been fired for forty seconds by Aerojet-General Corporation at Sacramento, Calif. The motor weighed 55 tons and contained 50 tons of polyurethane propellant. Dimensions of the segmented motor were 30 feet long and 8 feet, 4 inches, in diameter.

It is predicted that by 1964 the Defense Department will test a solid rocket engine which will develop 2 to 3 million pounds of thrust.

Missile Developments

Vectorable nozzles are being used for the Minuteman solid ICBM. Each nozzle weighs about 200 pounds, and less than 10 per cent of this weight is used in movement mechanism. Four such nozzles are used in the first stage. The outer shell is steel with plastic insulator and exit cone; graphite is the core liner, and refractory metal serves as the throat liner.

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

Rockets & Missiles

Dual-thrust solid motors are being used on the Tartar missile. Boost thrust is high and for short duration; this is followed by a lower thrust level for a long duration. Both boost and sustainer are combined within the same motor. It is the first of the type in actual Navy use. Recently the Tartar missile downed a jet drone flying 20,000 feet above the Atlantic Ocean. Two guided-missile destroyers are armed with Tartar: U.S.S. CHARLES F. ADAMS and the U.S.S. JOHN KING.

The *Navy's Sparrow III* will use solid propellants rather than the previously anticipated prepackage liquid system. The new rocket will have greater than the present 1,500-mile-an-hour speed capability of the present Sparrow which is 12 feet long, has a diameter of 8 inches, and weighs 400 pounds. Range is over 5 nautical miles.

The Judi I solid rocket set a new high-altitude mark for weather research over the Pacific Missile Range. The rocket, carrying a payload of 9.5 pounds, reached an altitude of 240,000 feet. A previous Judi I rocket hit 236,000 feet. A 6.5 pound Loki II reached 231,000 feet.

A throttlable solid motor has been disclosed by Amcel Propulsion. Two sections are used for the motor: a fuel-rich grain, the other an oxidizer grain, and a throttle valve standing in between. Thrust range was 20 to 65 per cent of the maximum static thrust of 450 pounds. The specific impulse is said to be 227 seconds at 1,000 p.s.i. The oxidizer grain is said to be 90 per cent ammonium perchlorate.

The reliability of the *Minuteman XM-55 first-stage engine* is about 90.5 per cent. The solid engine has 9 components and in 132 complete engine tests has an accumulated running time of 2,350 seconds. In contrast, the LR-89 (Atlas) liquid engine has 33 components, had completed 3,177 complete engine tests, an accumulated running time of 155,750 seconds, and a resulting reliability of 91.4 per cent.

High-thrust solid motors are to be tested at the Army Ordnance Missile Command, Redstone Arsenal, Huntsville, Ala. The new facility will be on the southern part of the arsenal. Motors will be tested horizontally. Other structures are an earth-covered terminal building and a control building.

Electric Rockets

The first in a series of ion engines has been delivered to the Air Force. One motor has been reported to have developed 3.2 millipounds of thrust using 61 beams. Successful operation without failure has been achieved for 170 hours. Efficiencies of 65 per cent are reported, and specific impulses were in the range of 5,000 to 8,000 seconds. Thrust-to-power ratios have been in the 275 kw/pound range. Cesium is the ion material. The engine was developed by Electro-Optical Systems.

A thrust of 1.6 millipounds has been achieved in a Hughes Aircraft Company engine with a specific impulse of 9,000 seconds and 58 milliamps' beam current. The engine has been under development for a flight-test program.

Late 1962 is the date NASA is shooting for in a space experiment of an ion engine when a Scout rocket will orbit a Hughes ion engine (cesium fed) and a Lewis Lab (NASA) engine using an electron-bombarded mercury beam. A second Scout rocket is slated to test the 61-beam cesium-ion engine described above and a Plasmadyne plasmajet.

Power supply for the ion and electric engines also requires development. There is need for higher powers than the present 30-kilowatt limitation of the Snap 8 generator.

Avco has reported on its radiation-cooled arc-jet engine which uses hydrogen or ammonia as a working fluid. Continuous operation to 100 hours has been reported and specific impulse was 1,000 seconds with ammonia.

The NASA Lewis engine has a specific impulse in the 11,000-second class.

If ion power supplies can be brought down to about one milliwatt and under ten pounds per kilowatt in weight, then electric propulsion systems could carry payloads to any planet in our solar system.

Missiles

Details of new missiles recently announced under development include the following:

The *Cobra* 20-pound antitank missile produced in Germany is being considered for use by the U. S. Army; the Marines already have planned to purchase them.

No contract has yet been announced on the *Crow*, a Navy air-to-air missile; it is believed to have been flight-tested.

The *Eagle* program has been canceled. This nuclear-armed air-to-air missile of 100 miles' range was designed for launch from the Missileer aircraft.

A mobile antimissile defense system, known as *Fabmids*, is now under feasibility study by six contractors.

No contract has yet been announced for the Navy *Gimlet* air-to-surface ballistic missile.

The Air Force *Joshua* lightweight ICBM is still under study, but some equipment has been developed.

Lobber is still under study; this surface-to-surface cargo delivery system is said to have a 10- to 15-mile range. Equipped with a warhead, it is known as the *Ballista*.

Missile A is the Army Rocket and Guided Missile Agency's surface-to-surface missile with 10- to 20-mile range now in design study.

The Navy's *Raven* air-to-surface missile (500 miles' range) also is under study, but no contracts have been announced.

The Marine *Semper* missile is said to be under test at Point Mugu, Calif. It is believed to be an air-launched missile, but no contracts have been awarded.

Slam is the Air Force surface-to-surface, supersonic nuclear ramjet. It is now under development.

Terne is a Navy missile being developed in Norway. This surface-to-underwater antisubmarine missile is said to weigh 264 pounds, and carries a high-explosive warhead. Two destroyer escorts will be equipped with the missiles.

An advanced *Terrier* missile is now fleet operational. It has about double the performance capability of the older Terrier Navy missile.

Work has been started on the Navy *Typhon* missile. It is a surface-to-air missile and is said to use components of the Super Tartar and Super Talos; as such it would have a solid booster and ramjet sustainer. The supersonic missile would use conventional warheads.

Wagtail is an Air Force solid-rocket missile designed for low-level missions. The air-to-ground weapon would be designed to fly over land contours such as hills or trees.

Boosters include the NASA *Delta* which will succeed the Thor-Able and be able to place a 480-pound payload in orbit. *Phoenix* is being studied as a recoverable booster system for the F-1 liquid engine cluster. *Anna* is a geodetic satellite. *Aeros* is a 24-hour satellite to be boosted by Centaur. *Arents* will use the Atlas-Centaur. *Csar* will be a series of 2-ton satellites. *Rebound* will consist of multiple Echo satellites. *Relay* will use Delta and Agena B. *Yo Yo* will be a one-trip satelloid, sea-launched by the Navy.

Polaris Test Facility

A unique underwater launching facility for testing of the Polaris missile was completed recently. Technically called "Variable Depth Launch Facility," it was installed underwater at the San Clemente Island Test Range of the U. S. Naval Ordnance Test Station. The device will be used in test firing missiles from various ocean depths and consists of four separate movable steel spools, stacked on top of each other to form a tower, and anchored to concrete-filled steel pilings set deeply in the ocean floor. The spools are buoyant welded steel pipe structures, forming the underwater launch tower capable of withstanding a 300,000-pound eccentric load.

Located about twenty-five feet from the launcher are two telescoping towers equipped with twelve high-speed underwater cameras for recording documentary trajectory data of firings.

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FROM THE RECORD

Defense and Space

GEN. B. A. SCHRIEVER
Commander, Air Force Systems Command

PEOPLE sometimes think that the "challenges of space" are something to be faced only in some possible future conflict. They forget that this nation is engaged in an intense and continuing competition right now. As President Kennedy recently said:

"Today no war has been declared—and however fierce the struggle may be, it may never be declared in the traditional fashion. Our way of life is under attack. Those who make themselves our enemy are advancing around the globe. The survival of our friends is in danger, and yet no war has been declared, no borders have been crossed by marching troops, no missiles have been fired." And, Mr. Kennedy added, "No war ever posed a greater threat to our security."

We need to be clear about the nature and the seriousness of this contest. It is the age-old struggle between freedom and tyranny, a struggle that has taken a variety of forms throughout history. It is now being waged on the political level, the economic level, the ideological level, and even—to a limited degree—on the military level.

But in our time the contest has become more serious than even before because of the tremendous powers that have been given to man through unparalleled advances in science and technology.

I have said many times before that for the military planner space is a medium—not a product like an atomic bomb. Exploration of this environment promises a high potential for national defense. It therefore seems to me a matter of highest urgency that this nation exploit to the fullest the possibilities which space offers in strengthening our strategic position. . .

In the interest of national survival we must not be inhibited in exploiting space and in conducting the research and development necessary to discharging our basic responsibilities of defense and survival.

Thus it is obvious that the Nation's interest in space must be broader than any single program or project. It must encompass all our varied activities, both military and civilian. Our military space developments have as their primary purpose the increase of our Nation's military strength. This is necessary as long as our freedom is under attack.—*Before the Michigan Aeronautics and Space Association, Detroit, Mich.*

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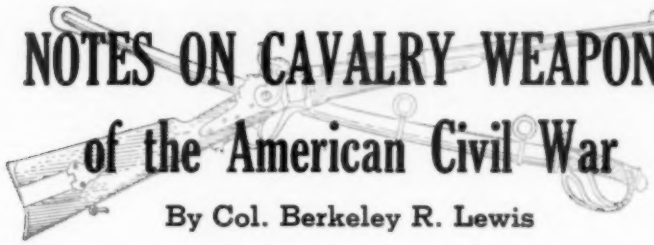

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MATERIALS PROGRESS

George S. Brady

Thermoelectric devices, already in small-scale production, seem headed for extensive commercial development during the next five years, and may require a revamping of the supply situation for a number of the relatively scarce "rare metals." Highest energy conversion efficiencies, and the important factor of low thermal conductivity for easier control of the temperature gradient, have so far been obtained with tellurium compounds. If this trend continues, Bureau of Mines believes that at least 300,000 pounds of ultrapure electronic-grade tellurium will be needed annually to supply the demand.

Units for the conversion of atomic reactor heat directly into electrical energy have been the prime object of the research, but for some time to come this use would be small compared with the needs for coolers, refrigerators, and air conditioners. In these the thermoelectric material is used in reverse with an applied electric current acting to "pump out" the heat.

At least one company is now in regular production of units suitable for water coolers and small household-type refrigerators. Cost is the present governing factor, but outstanding advantages are the very small size of the cooling unit and the absence of all moving parts except the fan. A compact air-conditioning unit for automobiles is a near possibility. Projected military uses are many, one important one being the cooling of electronic devices.

Right now, lead telluride is being advocated for the high-temperature applications of heat-electric conversion. Bismuth telluride is somewhat more efficient, but is limited to temperatures below 400 degrees centigrade, and is the preferred material for cooling and refrigerator uses.

Bell Telephone Laboratories has developed a silver-antimony-telluride, $AgSbTe_2$, which is stated to be electronically efficient, and which has extremely low thermal conductivity suitable for temperature-gradient control in the "heat-pumping" cycle. This compound contains a higher proportion of the scarce tellurium metal than does lead telluride, but improved methods of using thin films can cut down on the over-all metal requirements.

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

Tellurium Supply.—Thus, tellurium supply now seems at a crossroads. It is entirely a by-product metal depending on extraction of residues from copper and lead production, and no direct ores that could be worked economically are in sight. One road open is to cut down on the older uses in tellurium lead, tellurium copper, and rubber accelerators. The other course, and the most probable one, is to continue research for new compounds and new methods for thermoelectrics.

Westinghouse has two new thermoelectric materials that appear to have good stability and good thermoelectric properties to temperatures as high as 2,000 degrees Fahrenheit, but these are likely to be used only in the high stages in conversion devices. They are cerium sulphide and samarium sulphide, made by a controlled reaction of sulphur with the rare metals, crushing, and compacting into cylindrical pellets which are then sintered.

Despite the rarity of the metal, cost of the commercial grades of tellurium used for alloying and for rubber is not excessive compared with the costs of other rare and noble metals. But refining to obtain the ultrapure grade required for thermoelectrics adds greatly to this cost. The tellurium being produced by the *Penn Rare Metals Company* is 99.9999 per cent pure. The present price quoted for ultrapure lead telluride by *Semi-Elements, Inc.*, Saxonburg, Pa., is $500 per kilogram. However, most thermoelectric devices require only minute quantities of the material.

Titanium Alloys.—Emergency oxygen supply bottles for aircraft pilots, made by *Wyman-Gordon Company*, Worcester, Mass., are forged from Titanium alloy 13V-11Cr-3A1. The bottle weighs 3.5 pounds and carries oxygen at 3,000 pounds per square inch pressure.

This same company also is using a titanium alloy for extruded and die-forged rocket motor cases and closures up to thirty-six inches in diameter. The material is the same beta alloy containing 13 per cent vanadium, 11 chromium, 3 aluminum, and the balance titanium. After aging at 900 degrees Fahrenheit, the forgings have a tensile strength of about 195,000 pounds per square inch, yield strength of 185,000 pounds per square inch, and a minimum elongation of 5 per cent. It has been found that cold work before aging improves the physical properties by "nucleation" distribution of the alloying elements throughout the titanium matrix.

Titanium metal production is still going largely into military uses, chiefly because of high cost for the finished forms, but its high corrosion resistance plus its high strength with low weight is extending its use in chemical plants. A typical application is in the steam coils for heating 30 per cent sulphuric acid at the pigment plant of the *National Lead Company*. With the high-alloy tubes formerly used there was an excessive build-up of metallic sulphides in the coils which could be removed only by a costly scraping process.

With seamless titanium tubes (two inches outside diameter) the deposits can be removed with a simple periodic boil-out without scraping. The titanium coils cost 45 per cent more than the alloy units, but lower installation cost of the lighter-weight units, reduced maintenance time, and the fact that a higher heat-transfer value gives greater efficiency at a lower steam pressure, more than offset the cost differential. The titanium coils were furnished by the *Saffran Engineering Company*, St. Clair Shores, Mich.

The National Aeronautics and Space Administration has found that graphite parts coated with titanium nitride will withstand a temperature of 3,600 degrees Fahrenheit in a Mach 2 airstream. The coating is applied by a gas-torch method.

Calcium Fluoride.—Engineers at the Lewis Research Center of NASA also have found that thin surface films of pure calcium fluoride on bearings reduce the friction coefficient to 0.06 at 1,500 degrees Fahrenheit. For lubrication below this temperature the calcium fluoride can be made more adhesive with about 25 per cent of a ceramic binder.

Another research finding at this center is that adding very fine fibers or "whiskers" of tungsten metal to copper or copper alloys increases the strength greatly. Copper wire that normally has a tensile strength of 30,000 pounds per square inch will have a strength of 120,000 pounds per square inch when 35 per cent of tungsten fibers is added. (*Continued on p. 284*)

A look at what's ahead in the realities of space exploration

Some predictions from Douglas —builders of Thor which has launched 80% of all successful U.S. satellites & space probes in the past two years

Our mastery of space has advanced so rapidly that only diehard pessimists doubt the moon and planets will know our footsteps within a few decades.

Already a vehicle capable of orbiting a 19,000-pound payload, or driving 5,000 pounds to escape velocity, or lofting 2,500 pounds to Mars or Venus is being built in the U.S. This is Saturn, taller than a 14-story building, with an initial thrust of 1.5 million pounds. Its second stage, under construction for NASA by Douglas, will use a cluster of liquid hydrogen-oxygen engines of unique design.

The world knows a man can rocket into space and return. Can he survive for long periods? Douglas studies give a strong affirmative. Zero gravity and artificial G require further study. Radiation is a continuing problem, but reports from Discoverer XVII, one of 46 space projects launched by the Douglas Thor rocket, show the threat less serious than was first thought.

The cost of space travel? A breakthrough in nuclear power, which Douglas engineers confidently predict, should cut the operational cost of a trip to the moon to about $900 per passenger. Other power sources, already under study, may even open such stars as Sirius and Alpha Centauri to travel.

The DC-8 Jetliner, an example of Douglas aero-space leadership

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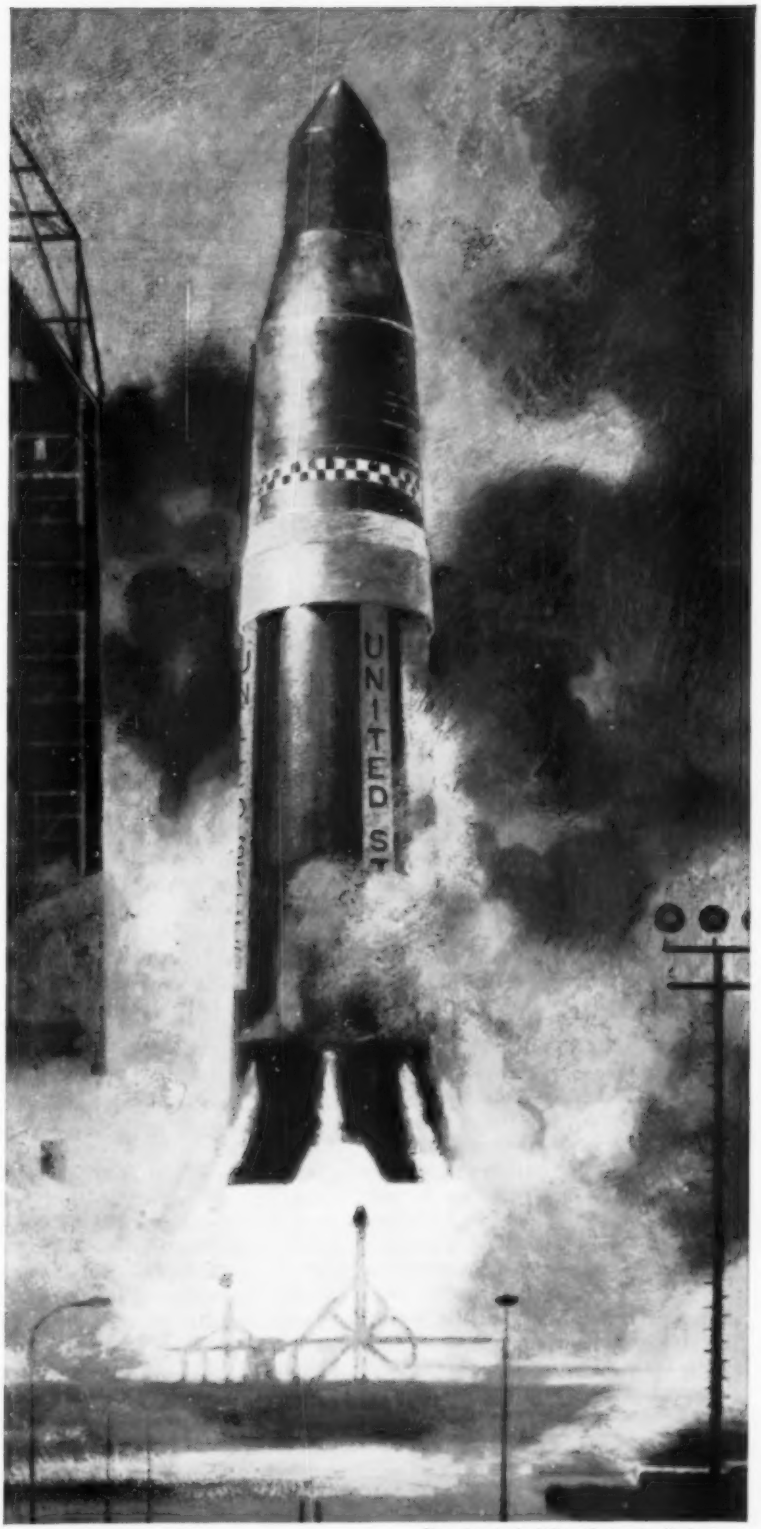

Douglas is building Saturn's 2nd stage.

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Materials Progress (Contd.)

Beryllium Oxide.—*National Beryllia Corporation,* Haskell, N. J., has been working on an Air Force research and development contract to develop fine fibers of single-crystal beryllium oxide for use in high-temperature structural products. The fine fibers are expected to have a tensile strength up to 2 million pounds per square inch. The melting point of the material is 4,650 degrees Fahrenheit.

Magnesium in Zinc.—*Dow Chemical Company* reports that the addition of small amounts of magnesium to the zinc increases greatly the corrosion resistance of galvanized steel. Hot-dipping with an alloy of 97 per cent zinc and 3 per cent magnesium adds about 0.05 per cent by weight of magnesium to the zinc coating.

Bacteria in Minerals.—It has been known for years that various types of bacteria operate on rocks and minerals, breaking them down and altering their chemical nature. But probably one of the first controlled applications of this is in the experiments of the Bureau of Mines in eliminating undesirable sulphur from coals by bacteria processing.

It has been indicated that as much as 65 per cent of the sulphur in coal can be removed in three days by treating the wet powdered coal with the bacteria Ferrobacillus ferrooxidans. The aim in this case is the elimination of the offensive-smelling smog in the burning of lower-grade coals, but bacteria processing may well be extended to applications on other minerals.

Wood Preservative.—Researchers at the *Koppers Company,* Pittsburgh, Pa., report that wood impregnated with pentachloro phenol has superior preservation qualities to those of wood treated with any other known preservative. Other advantages are that the wood is not changed in color, weight, strength, or working properties. Another recent finding in wood technology is that wood flour incorporated as a "filler" in urethane resin in producing rigid foam reacts chemically with the isocyanates and becomes an integral part of the plastic, improving the physical properties. *Wilmer Wood Products Company,* Norway, Maine, made the research.

Acetal Resin.—A gear pump designed by the *Planet Products Corporation,* Chicago, Ill., for handling corrosive liquids, has all parts except the shaft and by-pass pressure spring molded of acetal resin (Du Pont's Delrin). The only finishing operation required is the grinding to size of the gears and bushings. The resin has low friction, and the pump requires no lubrication. An added advantage for some applications is the low weight. The relatively new acetal resin is also being used by *Bohannon Industries,* Colorado Springs, Colo., for small drive chains and sprockets in high-speed, low-inertia applications.

Celanese Corporation of America, New York, N. Y., also has a new highly crystalline linear acetal resin, called Celcon, produced from trioxane. It is a translucent white material, and molded parts have a specific gravity of 1.410, a hardness of Rockwell M76, and flexural strength of 12,000 pounds per square inch. It has a dielectric strength of 1,200 volts per mil, and is being recommended for electrical and mechanical parts.

New Shotgun Shell.—A new "SP" 12-gauge shotgun shell of the *Remington Arms Company* has a head of steel, brass-plated, to replace the time-honored brass head. The body is of linear polyethylene instead of the conventional paper. The plastic adheres tightly to the steel, and has no tendency to tear away on extraction from the gun. It is also translucent, making the components visible. The old paper shell would swell on exposure to humidity and would deteriorate when wet, but the new steel-plastic shell shows no deterioration after long submersion in water.

Forming Hard Metals.—Explosive forming of hard and tough metals has been conducted successfully on a test basis by the *General Electric Company* without the use of dangerous chemical explosives. The new "capacitor discharge electro-spark forming" is done under water, with electrical blasts creating high-intensity shock waves directed against the metal to be formed. The impacts cause the sheet metal to take the form of the die, and parts as large as 10 inches in diameter and 3/32-inch in thickness have been formed with high accuracy and finish.

Nickel-Chromium Steels.—*Universal-Cyclops Steel Company* and the *International Nickel Company* have been conducting experiments on low-temperature rolling of nickel-chromium austenitic stainless steels. Rolling the steels at sub-zero temperatures is stated to produce a martensitic structure and to increase the tensile and yield strengths as much as 70 per cent with improved ductility. This "Zerolled steel" also is claimed to retain its strength at elevated temperatures better than steels rolled at normal temperatures.

New Rubber Plant.—*Goodrich-Gulf* recently announced that it was converting its styrene-butadiene rubber plant at Institute, W. Va., to the manufacture of polybutadiene rubber. It was stated that by polymerization with a cobalt catalyst an improved quality of polybutadiene can be produced at a price competitive with the old standard SBR (styrene-butadiene). It is claimed that the newer polybutadiene will give at least 60 per cent more wear in truck tires than natural rubber. *Phillips Petroleum Company* is also producing polybutadiene rubber.

Polyisoprene Rubber.—Butadiene is a vinyl ethylene, $CH_2{:}CH{\cdot}CH{:}CH_2$, and polybutadiene is not a "synthetic natural" rubber as is polyisoprene. Although natural rubber is a polyisoprene, the "synthetic natural" is not exactly identical chemically with the natural. However, it is more uniform in quality and easier to process, and it can be produced from the abundant propylene at a price which natural rubber may find hard to match even under the most favorable growing conditions.

Natural-rubber producers maintain that no man-made rubber can equal natural rubber in elasticity. On the other hand, rubber manufacturers maintain that maximum elasticity is not needed in the big-quantity rubber uses.

Road tests of polyisoprene tires have shown better crack resistance than for natural rubber. But the natural rubber producers say this is a matter of uniform purity, and that the newer high-grade processed natural rubber has a high uniform purity. New compounding with antioxidants and new curing systems also have increased the resistance of natural rubber to ozone cracking and breakdown. New compounding has increased the temperature resistance to 125 degrees centigrade.

Although world capacity for the production of synthetic rubbers is now greater than the capacity for natural rubber and is increasing rapidly, natural-rubber producers are far from pessimistic. They claim that new strains of rubber trees under special care and hormone treatment will produce three times the former yield. It is indicated that Malayan rubber can be sold profitably at around 25 cents a pound.

It is yet not easy to gauge the future position of natural rubber. The Rubber Manufacturers' Association predicts that 72 per cent of the rubber used in the United States in 1961 will be synthetic. In 1960 the percentage was 68.9, and in 1959 it was 65 per cent. Actually, American users bought 40 per cent less rubber in Malaya in 1960 than in 1959, but this appears more economic than technical. Soviet purchases of rubber in Malaya also dropped off, which may be attributable to a betterment in Russian synthetic production.

World capacity for synthetic rubbers appears to be increasing faster than the over-all rate of growth of total rubber requirements, but natural-rubber producers still believe that the natural industry can maintain its present total quantity position for a long time to come.

ARMAMENT ELECTRONICS

Traver B. Van Vliet

Transistor Microwave.—A transistorized microwave system, operating in the 6,000-megacycle region, has been developed by Motorola, Inc. The entire system, with exception of the transmitter's reflex klystron, uses transistors and modular construction in all stages. The system is designed for use by railroads, industry, and government.

Nimbus.—The Nimbus weather satellite, due to be launched next year, will carry three videcon cameras, covering a large area of the earth's surface with a resolution of 0.1-mile. The 650-pound satellite is scheduled to be launched from the Pacific Missile Range into a 600-mile polar orbit by a Thor Agena B booster, and will make 13 orbits daily.

Project Surveyor.—Under Project Surveyor, the National Aeronautics and Space Administration's Jet Propulsion Laboratory will launch seven space vehicles to the moon in the period from 1963 to 1966. The spacecraft will carry instruments which will provide data on the physical nature of the moon and may provide clues as to the origin of the moon and the solar system. Early Surveyor vehicles will determine if it will be necessary to continue the sterilizing of lunar spacecraft. The spacecraft also will provide information on density, hardness, temperature, and magnetic properties. An X-ray spectrometer also will be included to determine the presence of certain elements. The Surveyor spacecraft is being designed and constructed by Hughes Aircraft Company.

Scout Reconnaissance System.—Ling-Temco-Vought, Inc., is developing a small space reconnaissance system designed to be carried by a Scout-class rocket vehicle. The system will take high-resolution photographs, store the images, and transmit them to earth on command. Istar (image storage translation and reproduction) is being developed for the Bureau of Naval Weapons.

Mr. Van Vliet is a student of engineering and mathematics. He is active in amateur radio and also in experimental electronics. He lives in Northridge, Calif.

ICBM Microwave Link.—A microwave communications system has been installed at Fairchild Air Force Base, Wash., to link Atlas ICBM launch sites with an underground command control center. With the exception of the antennas, the entire system is housed in concrete-steel bunkers buried twenty feet underground. The 4-foot-diameter dish antennas are mounted in concrete pillars and are enclosed by one-inch-thick high-strength plastic domes. The installation was built by Collins Radio Company.

Air Traffic Control.—Federal Aviation Agency will soon begin flight-evaluation tests of the Air Force's AN/GSN-11 semiautomatic traffic control system. Capable of handling up to eighteen aircraft, the system provides each pilot with voice commands which tell him what his aircraft heading, altitude, and rate of descent should be for final approach. An earlier version of the system is the AN/GSN-3 Volscan, developed and built by the Air Force Cambridge Research Laboratories. The new system was built by Avco Electronics and Ordnance Division.

High-Power Klystron.—The Army has awarded a contract to Varian Associates for the development of high-power klystrons capable of producing average powers in the megawatt region. The tubes are needed in the Army's Nike Zeus and Zemar programs.

OAO Processing System.—International Business Machines Corporation will develop a digital data processing system for use in the National Aeronautics and Space Administration's orbiting astronomical observatory (OAO). The data processor is expected to weigh 130 pounds and will serve as a control center to aim the 3,500-pound satellite to any part of the celestial sphere.

Alaskan Air Defense.—Electronic air defense coordination systems (ADCS)—which give an air-defense commander complete tactical control over interceptor and air-defense missile batteries for the destruction of enemy airborne targets—have been installed in the Alaskan command and are fully operational. Each ADCS is composed of one Army air-defense system, one Air Force interception-control system, and a central tactical console. The ADCS encompasses four major functions: radar surveillance, interceptor control, missile control, and over-all air-defense coordination.

Air surveillance information obtained from local radars and remote tactical data obtained from battery-level elements by digital data link are presented to the air-defense coordination center. There, using the tactical console, an air-defense commander may monitor the over-all tactical situation or may assign attacking airborne targets to either Air Force interceptor controllers or Army surface-to-air missile battery controllers.

Each system includes one "operations central" and several battery equipments called "coder-decoders." The latter are located at missile batteries and provide them with electronic data on enemy and friendly aircraft entering the zone of defense.

Data on range and bearing of airborne targets are funneled into the operations central from local acquisition radars. Information on both friendly and hostile aircraft is displayed on radar indicators in the operations central. Via electronic digital data handling, the operations central sends target data to all units and can make target assignments to any unit. Status of a battery's defense can be relayed through the coder-decoder to operations central.

Synthetic markers are displayed on the commander's console which give him a complete picture of both the interceptor and missile-battery status. He may assign targets for either missile or interceptor engagement.

The primary function of the Air Defense Command is to monitor the over-all tactical situation and see that both missile and interceptor firepower is utilized properly, without unnecessary duplication. Operation of these systems to date indicates a substantial improvement in the over-all coordination of the air-defense elements in Alaska. The Army portion of ADCS was developed by Hughes Aircraft Company.

Venus Probe.—The Jet Propulsion Laboratory of NASA is due to launch its Mariner A spacecraft late next year in an attempt to return data on the physical nature of Venus. The spacecraft will be launched from Cape Canaveral by an Atlas-Centaur boost vehicle. The 26-million-

mile trip will take between 91 and 158 days, depending on the launching date. The spacecraft will be programmed to miss the planet's surface by about 16,700 miles. If technical problems prohibit launching, it will be necessary to wait another nineteen months for the next appropriate launch date. Some of the data which will be gathered include surface temperatures, the quantity of interplanetary plasma, and to ascertain the existence of Van Allen radiation belts around the planet Venus.

Countermeasures System.—The automatic AN/ALQ-27 electronic countermeasures system, developed by Sperry, will soon begin flight evaluation at Eglin Air Force Base, Fla. The system is designed to select and control countermeasures equipment required to jam or deceive enemy radar.

FSK Converters.—Hoffman Electronics Corporation's Military Products Division will produce frequency-shift converters for the U. S. Navy Bureau of Ships. The units are used in the operation of automatic teletypewriter printers—part of the standard communications equipment used throughout the Navy.

The units, designated AN/URA-17, are completely transistorized for compactness and light weight. The units consist of two converters and two comparators and operate from the audio output of two ordinary communications receivers, selecting the better of two identically keyed FSK (frequency shift key) signals to drive the teletypewriter printers.

NATO IFF.—Packard Bell Electronics will manufacture airborne identification friend or foe (IFF) sets for five NATO countries. The identification units will be installed in first-line defense aircraft manufactured by Fiat for Italy, Greece, and Turkey, and by Messerschmitt and Dornier for Germany. Units also will be used to retrofit French fighter aircraft.

Project Artemis.—The Office of Naval Research announced that it is sponsoring Project Artemis as "an exploratory development effort to determine the feasibility of using a high-powered sonar transducer and high-gain receivers, together with advanced data-processing equipment, for locating submarines at very long range in large ocean areas." The sonar transducer converts electric waves into sound waves.

Digital Communications.—George Marshall Space Flight Center, National Aeronautics and Space Administration, has awarded a contract to Packard Bell Electronics to determine the feasibility of a new digital communications concept proposed by the firm's Advanced Technology Laboratory. The new technique would increase communications efficiency by eliminating redundant data prior to transmission, thereby allowing more information to be transmitted over existing facilities.

The technique was conceived to reduce cost and weight in satellite and telemetry applications. The company estimates that the feasibility study will require six months to complete.

Relay Satellite.—Radio Corporation of America has received a contract from the National Aeronautics and Space Administration to develop the Relay active repeater communications satellite. The contract calls for the delivery of four satellite units—two for flight, one prototype, and one spare. Delta launch vehicles will be used for component tests and Atlas-Agena B vehicles will be used for complete spacecraft flights.

Datico.—An advanced electronic system, Datico, that can check the physical fitness of humans, assure the flight readiness of jet airplanes, monitor air traffic control radar, and control complex industrial production operations has been developed by Northrop Corporation. For example, Datico could be linked to newly developed subminiature transducers which are attached to a patient's body. The device then could automatically compare signals received from these transducers with signals measured under normal, healthy conditions. Datico applied in this way would give physicians a new and sophisticated instrument for the detection and diagnosis of illness.

Initially developed for military applications, the system already has been applied successfully to the testing problems of several military systems including Hawk, Nike Ajax, Nike Hercules, Sergeant, Lacrosse, and Corporal missiles, airborne electronics systems, and shipborne radar.

For the Polaris system, Datico is used aboard the nuclear submarines, the submarine tenders, at the missile production facility, and at the Naval Weapons Annex where missiles are received from the production line and issued to the fleet. The system is used continuously to monitor, check out, and perform the launch countdown sequence for each of the Polaris missiles aboard the submarines.

Space Probe.—High-output transmitters and power supplies being built for the Air Force's space-probing "Haystack" antenna system will make it the most powerful radio facility in the world. It will be capable of probing the surfaces of the moon or near-by planets.

The A.O.A. Directory

The Annual Directory of the American Ordnance Association for 1961-1962 is available to members. This Directory is published in July of each year and has been mailed to the national and local officials of the Association, members of the Technical Divisions, and A.O.A. company members. Other members may receive a copy on request. The Directory lists the following:

- Members of the Association's Council
- National Board of Directors and Executive Committee
- National Officers and Advisory Board
- Officers and Directors of All Local Posts
- Members of the National Technical Divisions
- Honor Roll of A.O.A. Company Members
- Organization Chart of the National Association

The Directory shows the A.O.A. office held by each individual listed and also gives his company affiliation and location. It is available to Association members only. Address requests to:

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SPACE ARMAMENT

Saturn Launch Complex

Construction has been completed on a massive rocket launching site at Cape Canaveral, Fla., from which early Saturn space vehicles will be fired. It is the largest known rocket-launching site in the world, and the first such base built especially for the peaceful exploration of space.

From this site the first Saturn heavy space vehicle will be fired in an experimental flight to test the booster propulsion system later this year. This will be the beginning of a series of large rocket test flights which is expected to lead, by 1965, to the launching of tons of instruments to the moon and Mars, and early versions of the 3-man Apollo spacecraft which ultimately will be used for manned lunar landings.

The facility, known technically as Launch Complex 34, recently was turned over to the National Aeronautics and Space Administration by the Army Corps of Engineers. The complex includes:

1. A 45-acre installation, dominated by a movable structure 310 feet high containing 2,800 tons of steel.
2. A blockhouse with walls 12 feet thick, having a steel door 2 feet thick weighing 23 tons.
3. Efficient fuel and liquid-oxygen storage facilities which are capable of pumping 750,000 pounds of fluid into the big booster in less than an hour.
4. A launching pedestal foundation reenforced by 4,400 cubic yards of concrete and 580 tons of steel.
5. A total of 100 million pounds of concrete used in construction.
6. A unique automatic ground control station, a room 38 feet wide and 215 feet long, located beneath the concrete and steel launching pad.

Micrometeorite Layer

The Air Force has announced the discovery of what appears to be a dense band of micrometeorites which envelopes the earth at extreme altitudes. This discovery was made recently by the Air Force Cambridge Research Laboratories, Bedford, Mass., when the contents of a novel rocket nose cone especially designed for trapping micrometeorites was examined. The density of the micrometeorites in this layer was totally unexpected. About ten of these small particles struck each square centimeter of the detecting surfaces each second.

The dust particles, measured in microns (thousandths of a millimeter) apparently

PACKAGING POINTERS

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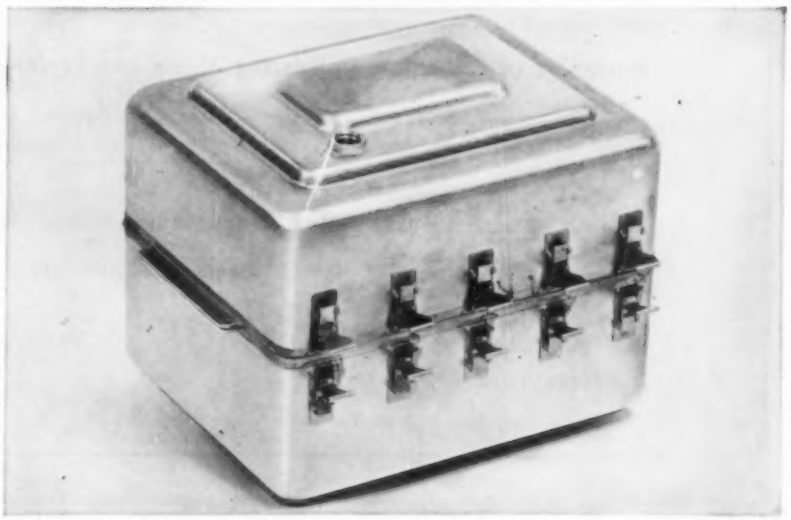

This lightweight deep-drawn aluminum housing is designed to withstand internal or external pressures of 15 psi. It houses an air data computer mounted on a casting having a gasketed male and female groove. Each half of the housing fits into these grooves (see sketch), completely protecting the instrument. Each half of the housing has 10 quick-disconnect latches that latch onto the instrument-mounted casting. Tiny holes in the latches make it simple to slip a sealing wire around the housing. Now compare this mounting method to the expensive way of making a housing out of a heavy casting that is soldered together and equipped with the "sardine can" type seal. The savings in this application will be 50% in weight, 40% in cost.

SPECIFICATIONS

Material:	6061-T6 aluminum
Gauge:	0.063-in.
Pressure requirements:	15 psi internal and external
Dimensions (each half):	8-3/8-in. wide x 10-1/3-in. long x 3-45/64-in.
Weight:	3 pounds total
MIL specs:	can be adapted to meet all applicable military specifications

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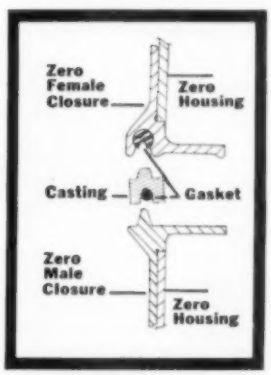

Cross-section of the Zero male and female closure extrusions. They are spot welded to each half of the housing and then sealed with a special epoxy. When used without the separating casting the two extrusions mate to form an airtight closure.

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exist as a band about the earth that is independent of latitude or longitude. The precise altitude at which these micrometeorites are concentrated will be determined by future tests now planned by AFCRL.

The special nose cone for trapping and recovering the micrometeorites was designed by scientists and engineers of AFCRL and Aerojet-General Corporation. It consisted of a podlike arrangement made up of individual petals or leaves. At an altitude of forty-seven miles these leaves opened like a blossoming flower.

The nose cone was carried to a maximum altitude of 102 miles over the desert at White Sands, N. Mex. The leaves closed again when the rocket descended to sixty-five miles. Altogether the nose cone remained opened for about four minutes.

One of the micrometeorite detectors used consisted of a triple layer of physically separated mylar and plexiglass sheets, each about two by three inches. Detectors of this type were located on each of the leaves of the nose cone. The top layer consisted of a mylar film 1/4-mil (1/4000ths-inch) thick. The second layer, also of mylar, was 1 mil. The bottom layer was a 1/8-inch-thick sheet of plexiglass.

The micrometeorites, traveling at speeds up to forty-seven miles a second, passed through the two mylar film layers, creating many holes. Most of these were microscopic in size, although many were visible to the naked eye. When they struck the harder plexiglass layer below, small craters, also readily visible, were created.

Some of these extraterrestrial particles were collected intact. Of particular interest to AFCRL scientists are the residual bits of meteorite material lining the walls of the craters. These residual materials will be analyzed by physical, chemical, and radioactive techniques.

Triple Play in Space

The United States successfully executed the first triple play in space history recently when an Air Force Thor-Ablestar rocket boosted three earth satellites into orbit from Cape Canaveral, Fla. The new space triplets are Navy Transit 4A, Injun, and Greb satellites. Mounted in tandem in the rocket's nose section, they were separated from each other and ejected independently into a 500-nautical-mile circular orbit by the Ablestar upper stage.

Transit 4A is a spherical 175-pound, 49-inch-diameter space lighthouse being developed by the Navy to determine the feasibility of a navigational signal station for ships and aircraft and to gather geodetic information. This electronic radio star is similar to the other three Transit satellites previously placed in orbit. Injun is a 40-pound cylinder, 16 inches in diameter and 13 inches high, designed to obtain detailed information concerning the composition of the geomagnetically trapped radiation zones and the aurorae. Greb is a 55-pound, 18-inch-diameter sphere that measures two forms of radiation emitted by the sun. It is the second time a Greb has been orbited.

Bacteria in Space

The National Research Corporation, Cambridge, Mass., will investigate the effects of simulated space environments on the life of microorganisms for the NASA. The program calls for studies of at least six representative species of common earth bacteria to determine their ability to survive such hazardous space conditions as ultraviolet radiation and ultrahigh vacuum, temperature, and desiccation for varying periods of time.

The microorganisms will be subjected to the ultrahigh vacuum range of 10^{-10} Torr (millimeters of mercury) which is equivalent to the very low pressures encountered at orbiting altitudes beyond 500 miles. The ability of common microorganisms to survive in the space environment may influence the preparation of future interplanetary probes.

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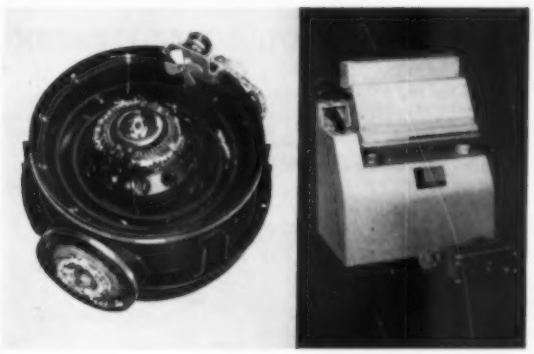

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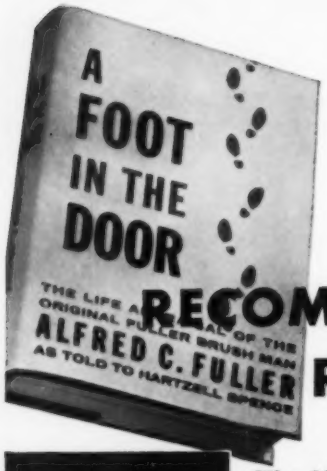

RECOMMENDED READING

The Heart-warming Life Story of the Original Fuller Brush Man — Alfred C. Fuller

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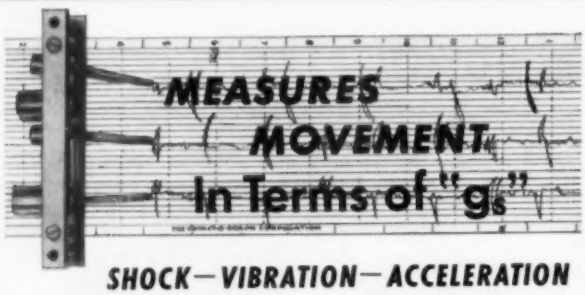

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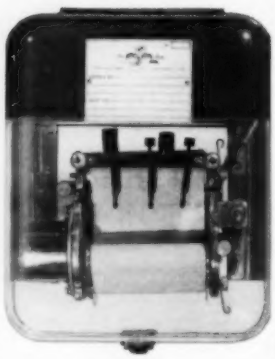

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Book REVIEWS

Reviews in this issue by:

LEO A. CODD, *editor, Washington, D. C.*

DR. JAMES B. EDSON, *senior assistant for missiles and space, Office, Assistant Chief of Staff, Army Intelligence, Washington, D. C.*

STANLEY L. FALK, *military historian, Washington, D. C.*

MAJ. GEN. E. P. MECHLING, *aviation ordnance expert, editor, Washington, D. C.*

COL. H. C. THAYER, *ordnance management engineer, logistician, Washington, D. C.*

Arms Control, Disarmament, and National Security.—Edited by Donald G. Brennan. New York: George Braziller, Inc. 475 pp. $6.

THIS impressive volume comprises a score of papers by American analysts originally published in the "Arms Control" issue of *Dædalus*, the journal of the American Academy of Sciences. Five new papers and some comments by foreign observers have been added. The authors cover the fields of science, technology, weaponry, economics, law, strategy, and political policy making.

The collection is under the editorship of Donald G. Brennan, research mathematician and communication theorist at the Lincoln Laboratory of the Massachusetts Institute of Technology.

This reviewer was particularly impressed by the realistic views of Dr. Edward Teller and Henry A. Kissinger. Many of the others impressed me by their wordiness on theories and viewpoints which lack the objectivity of reality. The editor in his opening paper, "Setting and Goals of Arms Control," leads the parade of unrealistic approach.

In appraising the goals which armament is intended to serve, he reveals a startling vacuum. The goal, he writes, "is survival —national survival at the level of the nation. But it is possible to distinguish different kinds of survival—physical survival, political survival, survival of standard of living."

To this classification Henry Kissinger suggested to the author the addition of "moral survival." Editor Brennan adds by way of footnote, "This is a very important point and I should do so but for the fact that it would complicate the following discussion."

Man alive! How theoretical can the doctrinaires get? If the moral aspects of survival are not worth revising the theory to meet the facts, what in Heaven's name is worth while?

The strange thing about the millions on millions of words that are written about arms control is that few outside the military-industry complex take the morality of the case into consideration. Won't the theorists some day soon see that integrity, honesty, and truth are basic elements without which attempts at arms control are futile?

The whole problem of arms control was expressed in all simplicity and starkness by James Burnham in the January-February 1961 issue of ORDNANCE: "The biggest bomb ever built or building is less than David's slingshot without a mind and will

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and arm able and ready to use it." Yet Mr. Brennan could not change his outline to consider the moral factor!—Leo A. Codd.

Editor's Note: Mr. Burnham's article under the title, "The War We're Not Prepared To Fight," was republished in condensed version in the July 1961 issue of *Reader's Digest*.

Rocket Development. Robert H. Goddard. Edited by Esther Goddard and G. Edward Pendray. Englewood Cliffs: Prentice-Hall, Inc. 222 pp. $2.45.

MOST of the great epics were written by poets or by the masters of prose. Here is one from the pen of the man who lived it. The language is that of the scientist and the engineer—careful, concise, impersonal. These are Goddard's own consolidated experimental notes of the first twenty-two years of liquid-fueled rocket development.

Page by page, test by test, the story unfolds from the firing of the very first crude device in 1929. The long, laborious years bring their harvest of progress. At the last, the whine of turbopumps is drowned in the roar of jet ignition and a rocket that is in every concept as modern as today's lifts off under the guidance of gyro-controlled jet vanes.

Once, long ago, I had the privilege to visit Dr. and Mrs. Goddard at his rocket laboratory in New Mexico. There, he and one professional assistant were performing all the diversified kinds of activity found today in the great laboratories, factories, and firing ranges of astronautics. As we stood by the door of his small machine shop he said that, some day, the arts that he had founded there at Mescalero Ranch would be the basis for a hundred great professions.

Now we who practice those professions may read in this little volume the story of our beginnings. With great vision, untiring hand, and often lonely heart, Robert Goddard was truly the opener of the road that now we follow.—James B. Edson.

America—Too Young To Die. By Maj. Alexander P. de Seversky. New York: McGraw-Hill Book Company. 230 pp. $4.95.

MAJOR de Seversky brings very substantial credentials to the writing of this book. His previous books and his long and intimate contact with key people in defense have earned him his role as a strong proponent of aerospace power. He criticizes with brutal frankness past and present leaders in Government who, he insists, are responsible for the low international and military prestige of this country.

The author appeals to the American people to have the Congress reestablish its constitutional control of raising and supporting military forces. He maintains that limited wars are no longer possible—they will become unlimited.

Major de Seversky believes that war with the Communists is inevitable and recommends a strong centralized military control of integrated forces with aerospace power as the critical element and with land and sea forces in supporting roles. He also believes in nuclear weapons with superior delivery systems and advocates top priority action to achieve a defense against ballistic missiles.

This book should be widely read—even by those who violently disagree with its thesis.—E. P. Mechling.

Newton D. Baker. By C. H. Cramer. Cleveland: World Publishing Company. 310 pp. $6.

THERE is a very cogent reason why members of the Ordnance Association are especially interested in a biography of Newton Diehl Baker. It is not because he was an outstanding American politician, orator, lawyer, and educator; nor because he served as Secretary of War throughout our country's participation in the First World War. The special reason for our interest is that Mr. Baker was a participant in the founding of the Ordnance Association in 1919.

In cooperation with Benedict Crowell, a fellow Clevelander who had served as Assistant Secretary of War and Director of Munitions, Mr. Baker saw the need for an association, led by civilians, which would keep American industry and the military in close liaison in time of peace in all phases of armament development and production.

The lack of this relationship prior to the First World War was largely responsible for the delay, waste, and bungling of the early stages of that conflict. Baker and Crowell spearheaded the founding of the A.O.A. in 1919. They were aided by others who were similarly minded.

Forty-three years later the wisdom and foresight thus shown continue to pay dividends a hundredfold to our national defense.

Dr. Cramer does not include this contribution in his narrative. Yet when the Association conferred the Ordnance Medal of Merit upon Secretary Baker in 1935 before a distinguished audience in the Nation's Capital, it cited him for his postwar leadership in sponsoring "for the first time in the history of our Nation the means for the mobilization of material resources and industrial strength as essentials of national defense."

Secretary Baker's life was a full one. A conservative Democrat who could not stomach the New Deal of Franklin Roosevelt, he combined the liberalism of Thomas Jefferson and the loyalty of Robert E. Lee. His beliefs shone forth in his education at Johns Hopkins, his youthful legal practice at Martinsburg, W. Va., where he was born, the child of Confederate parents. And so it was throughout his full career as Mayor of Cleveland, Ohio, as Secretary of War under Woodrow Wilson, as a leader of the conservative wing of his party, as a distinguished member of the bar, and as one of our country's best orators.

His record as Secretary of War was marked by patience, hard work, and much controversy. The latter stemmed from his earlier pacifistic outlook. But when war came and he was called to great responsibility, he served faithfully and with distinction. We who follow after owe Newton Baker a deep debt of gratitude. Our thanks go to Dr. Cramer who has written objectively and in the spirit of the man whose life he describes.—Leo A. Codd.

Notes on Guerrilla Warfare: Principles and Practices. By Col. Virgil Ney. Washington: Command Publications. 174 pp. $3.

GUERRILLA fighters long have been popular subjects for writers of biography, history, and fiction. However, studies of the principles of guerrilla warfare are relatively new, and the extension of Von Clausewitz' basic principles of war to incorporate in parallel such additional principles is unique, according to the author.

Colonel Ney in this book has listed a series of principles of guerrilla war and has discussed them using historical illustrations liberally. In general, his approach reflects his experience at high staff levels with the broad, big-picture outlook. The principles enunciated appear sound, and illustrations from the recent history of guerrilla warfare aptly support his conclusions.

The reader should bear in mind that the author is developing basic principles to be studied, remembered, and used. Hence, the book seems more ponderous and more remote than some other works on this subject. For example, it does not discuss many of the small, intimate, but important operational details noted by Cuba's Ernesto "Che" Guevara in his recent book.

The necessity for applying Von Clausewitz' principles in guerrilla warfare is emphasized. However, Colonel Ney stresses the supplementation of those principles by additional ones, such as: Environment, community security, community support, propaganda, proximity, deliberate delay, personal security, part-time function, full-time function, modus

Book Reviews (Contd.)

operandi, and organization. As time passes, this list probably will be modified, but it does present a useful initial line-up for consideration.

To those unfamiliar with a formal, top-level analysis of the subject of guerrilla warfare, this cloth-bound pocket-size volume should furnish a useful approach. With this background, the reader may then evaluate more knowledgeably other works on guerrilla warfare, many of which are listed in the bibliography. —H. C. THAYER.

Ride to War: The History of the 1st New Jersey Cavalry. By Henry R. Pyne. Edited and with an introduction by Earl Schenck Miers. New Brunswick: Rutgers University Press. 340 pp. $6.

CIVIL War buffs will welcome the republication of Henry R. Pyne's fine history of the 1st New Jersey Cavalry, or Halsted's Horse, as the regiment was initially known. With an informative introduction and helpful notes and corrections by Earl Schenck Miers, as well as several handy battle maps, this new edition is even more useful than the original version published ninety years ago.

Halsted's Horse was the first Union regiment of volunteer cavalry to enter the field and the last to leave it. From its initial skirmish at Pohick Church, Va., in December 1861, to its final participation in the operations culminating in Lee's surrender at Appomattox, its record of nearly one hundred actions in Virginia, Maryland, and Pennsylvania was marked by dash, color, and, most important, frequent success.

Pyne, the regimental chaplain during most of the war, wrote one of the better—and certainly more readable—Civil War regimental histories. A felicity of language, a vigorous style, an attention to detail without becoming tedious, a respect for the tragedy of war balanced by an understanding nod to its lighter side—all make Chaplain Pyne's contribution a first-class piece of work.—STANLEY L. FALK.

BOOKS RECEIVED

Basic Mathematics, Vol. 2. By Norman H. Crowhurst. New York: John F. Rider Publisher, Inc. 136 pp. $3.90.

Civil Air Regulations for Mechanics. By Associated Aeronautical Staff of the publisher. Los Angeles: Aero Publishers, Inc. 152 pp. $4.50 hard cover; $3 soft cover.

Fundamentals of UHF. By Allan Lytel. New York: John F. Rider Publisher, Inc. 160 pp. $3.90.

Guide to Current Techniques in Financing, A. By Harry Gross and Maxwell J. Mangold. New York: Pilot Industries, Inc. 33 pp. $2.

Response of Metals to High Velocity Deformation, Vol. 9. Edited by P. G. Shewmon and V. F. Zackay. New York: Interscience Publishers, Inc. 486 pp. $18.

Tables of Blackbody Radiation Functions. By M. Pivovonsky and M. Nagel. New York: Macmillan Company. 481 pp. $12.50.

Temperature Measurement in Engineering, Vol. II. By H. Dean Baker, E. A. Ryder, and N. H. Baker. New York: John Wiley & Sons, Inc. 465 pp. $13.

Tool Steel Simplified. By Frank R. Palmer and George V. Luerssen. Reading: Carpenter Steel Company. 595 pp. $2.50, in the United States; $3 elsewhere.

Uniform Service Almanac. Compiled and edited by Lee E. Sharff in association with Wayne Hawkins and Joseph Young. Washington: Federal Employees News Digest. 146 pp. $1.

World Aircraft Illustrated. Edited by John W. Underwood. Los Angeles: Aero Publishers, Inc. 248 pp. $8.50.

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Inputs from BMEWS Provide Instantaneous Missile Data Direct to NORAD Headquarters

From our vast outer defense perimeter, over thousands of miles, to the nerve center of the North American Air Defense Command at Colorado Springs, the most advanced concept of data handling and checkout is being utilized in the BMEWS system. The stakes are high, for the purpose is defense of the North American Continent.

At BMEWS installations operated by USAF Air Defense Command, computers read out missile tracking data from giant radars. This information is simultaneously relayed to NORAD's Combat Operations Center.

The Radio Corporation of America is prime systems contractor for BMEWS. At the COC, RCA's Display Information Processor computing equipment automatically evaluates missile sightings, launch sites and target areas. By means of data processing and projection equipment installed by RCA and a team of other electronics manufacturers, the findings are displayed on huge, two-story high map-screens in coded color symbols, providing the NORAD battle staff with an electronic panorama of the North American and Eurasian land masses.

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Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use.

Adhesives for Ordnance

Epoxy-based materials are effective in the field to repair matériel

Eileen R. Swick

EPOXY resins are of prime importance to the adhesives field as the main constituent of numerous structural adhesive systems. The wide acceptance of these materials can be attributed to their excellent adhesive properties, their chemical and solvent resistance, and their strength characteristics over a wide temperature range.

Epoxy-based adhesives are extremely versatile in that a useful range of mechanical properties can be obtained by variation of curing agents, modifiers, and fillers. Pot life, or the time during which the adhesive is suitable for use after mixing, also can be varied in this manner.

Room-temperature cure of epoxy adhesives is usually preferred to elevated-temperature cure for practical applications. Adhesives cured at elevated temperatures often give superior strength properties, particularly at higher temperatures. However, they frequently present a problem in that they require the use of ovens and complicated jigging procedures, particularly in production applications where large assemblies are bonded.

Room-temperature cures are usually achieved by using aliphatic polyamine curing agents. Polyamides also can be used to cure epoxy adhesives at room temperature and simultaneously to modify them, making them tougher and less brittle. The reactions of epoxy resins with polyamides are only mildly exothermic as compared with reactions of epoxy resins with aliphatic amines. The aliphatic amines generally harden epoxy resins rapidly; polyamides require longer cure time at room temperature but provide a longer pot life.

Mrs. Swick, who is with the Materials Research Section at Picatinny Arsenal, Dover, N.J., conducted all experimental work reported in this article.

FLEXIBILIZERS such as polysulfides or other long-chain aliphatic materials frequently are added to epoxy resins to increase their toughness and impact resistance, especially at low temperatures. Some heat resistance is sacrificed by the addition of certain flexibilizers. However, loss of strength may be kept to a minimum while obtaining the desired modification by controlling the quantity of flexibilizer.

Fillers such as metal powder, mica, and silica (depending upon the intended application) are frequently incorporated in the epoxy adhesives. The addition of fillers is advantageous for the following reasons:

1. They increase the viscosity of the adhesive, thereby making it more suitable for bonding irregular surfaces where contact between the adherend surfaces is spotty.

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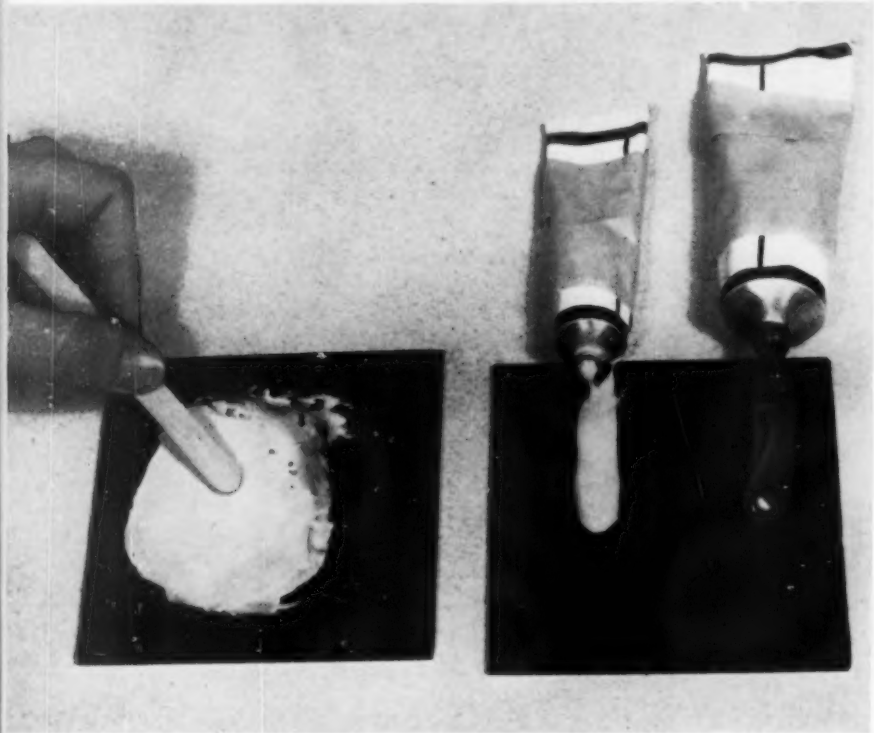


Fig. 1. A typical kit adhesive for field use before and after mixing.

2. They reduce the shrinkage of the resin that occurs during cure, thereby eliminating some of the stresses which occur within the adhesive.

3. They improve impact resistance and in some cases strengths of the bonded joints in general.

FILLERS also help reduce the cost of the resins, making them more practical for production applications.

Epoxy adhesives have found an increasing number of uses in the structural assembly of components for Ordnance applications and have been used by the Air Force for several years. They are presently being used with success in structural applications in the fabrication of many Ordnance weapons systems such as Lacrosse, Shillelagh, Red Eye, Minuteman, and Redstone.

However, the use of epoxy adhesives has been confirmed primarily to shop production and laboratories. One of the primary reasons for this is the need for accurate weighing and mixing of component ingredients, which ordinarily are supplied in large containers. The use of these materials in the field for repair purposes is impractical when accurate weighing is required.

Adhesives that have been supplied in convenient tubes or kits have been mostly solvent or water-emulsion thermoplastic types such as cellulose nitrate (household cement), rubber-based adhesives, and polyvinyl acetate adhesives. These thermoplastic adhesives are not recommended for good metal-to-metal bonds and resistance to high-temperature and climatic conditions.

Recently manufacturers have begun to distribute thermosetting epoxy adhesives in small kits or tubes which do not require weighing. These adhesives are solventless, have good heat and solvent resistance, and bond well to a wide variety of materials. In addition, most of them cure at room temperature.

The kits are supplied in packages composed of two units. One unit contains the adhesive resin and the other contains the hardener or curing agent. The units come either as collapsible metal tubes or as jars. When using the tube package, equal lengths of resin and hardener are squeezed onto a mixing plate and then thoroughly blended (see Fig. 1). When jars are the containers, a mixing cup is supplied.

THE components are basically (1) epoxy resins of the bisphenol A-epichlorohydrin type and (2) polyamides or polyamine adducts which are the hardeners or curing agents. In some cases modifiers and fillers may be present in the adhesive resin component.

These adhesive kits may have potential for Ordnance field-repair work, for they would make it possible for many Ordnance items that would normally be returned to a shop or Ordnance depot to be repaired in field repair stations. Numerous items could be repaired in almost any locality by untrained personnel, provided the directions supplied with each kit were followed carefully.

In cases of delamination or breakage of rubber or plastic parts, adhesives are usually the only means of repair. Metal components can be adhesive-bonded to withstand service requirements for many months or even years. The use of adhesives in these cases also would reduce repair time and cost.

It should be noted that these emergency repair kits are not recommended for permanent repair or for use in critical structural applications where failure of the adhesive bond would result in malfunction of the Ordnance item.

The decision to evaluate a few commercially available epoxy kits stemmed from their apparent potential for field repair. Eight kits were chosen at random and evaluated in tensile shear for

Table I. Shown below is the average adhesive shear strength to steel with epoxy kit adhesives cured for 7 days at 73 degrees Fahrenheit.

Adhesive	*Shear strength, psi, at degrees Fahrenheit*			
Kit	*—65°F.*	*73°F.*	*160°F.*	*73°F. after JAN cycling*
A	1,390	2,020	2,950	1,981
E	1,110	1,530	520	*
F	2,440	920	145	**

Steel specimens were acetone-wiped and vapor-degreased before bonding.
*Failed during 1st week of JAN cycle.
**Failed during 2nd week of JAN cycle.

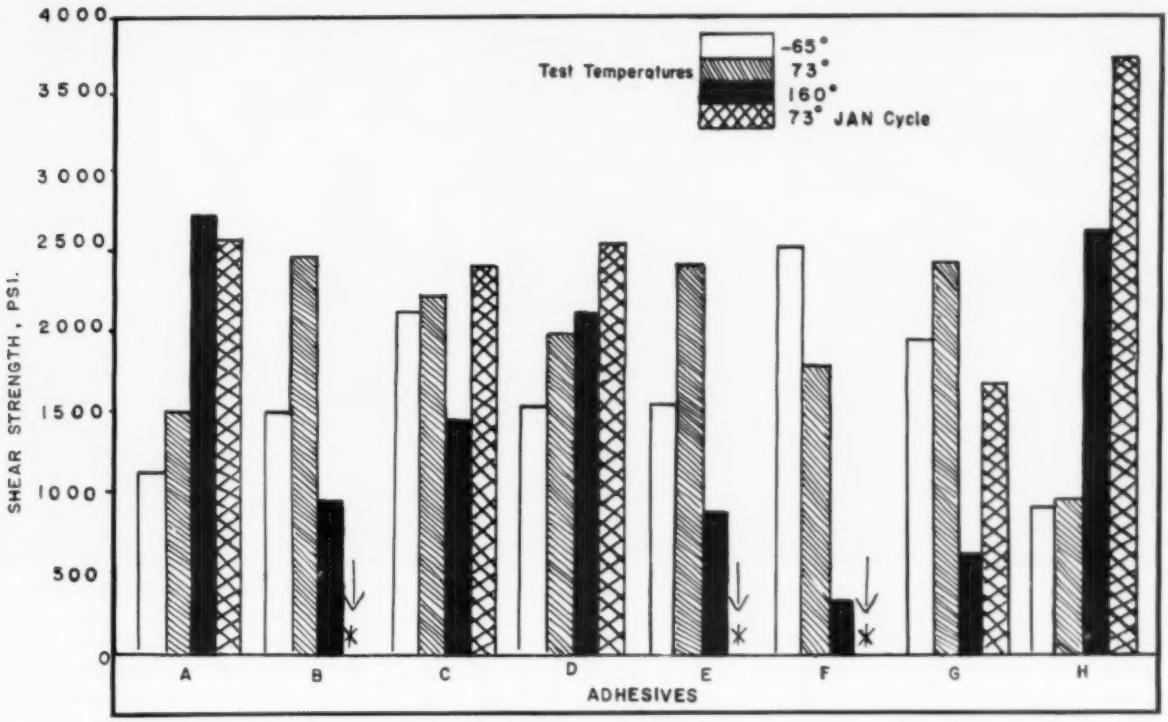


Fig. 2. Shown above are average adhesive shear strengths with aluminum using epoxy kits, with the asterisks designating specimens delaminated during JAN cycling. Test temperatures are indicated in the small box.

adhesive bond strength to aluminum at the standard Ordnance test temperatures of minus 65, plus 73, and 160 degrees Fahrenheit, as well as at 73 degrees Fahrenheit after subjection to the JAN temperature and humidity cycle (MIL-STD-354) for 28 days.

IN a preliminary investigation, three adhesives (A, E, and F) were evaluated for bonding steel to steel. The results are shown in Table I. Only Adhesive A withstood the JAN cycling. However, the steel corroded so badly in the JAN cycle phase of this test series that it was difficult to determine the cause of bond failure during the cycling.

It could not be determined whether the corrosion crept under and lifted the adhesive from the metal or whether the adhesive itself was attacked by the moisture, thereby exposing the bonding surface to the corrosive effects of the JAN cycling.

To minimize the effects of corrosion in evaluating the adhesives, aluminum adherends were selected for further evaluation tests of these three adhesives. In addition, five other adhesives were added to the test program. Of the eight adhesives evaluated, five withstood all environmental test conditions (see Fig. 2). These were adhesives A, C, D, G, and H. The most favorable over-all results were obtained with Adhesive C, which gave the following shear strengths after 7 days cure: 2,110 psi at minus 65 degrees Fahrenheit, 2,230 psi at plus 73 degrees, 1,470 psi at 160 degrees, and 2,420 psi at 73 degrees after JAN cycling. An average of 1,520 psi in shear with a standard deviation of 26.5 was obtained on 3 specimens at 73 degrees Fahrenheit after only 24 hours cure at 73 degrees with this adhesive.

Adhesives A and D gave bond strengths equal to Adhesive C under some conditions (specifically at elevated temperatures or after subjection to elevated-temperature storage), but they appear to require a post cure at elevated temperature, as is evidenced by the increased bond strengths at 160 degrees Fahrenheit and at 73 degrees after the JAN cycle. In the incompletely cured state the adhesives are likely to be more susceptible to solvent attack, salt water, and weathering.

ALTHOUGH Adhesive H gives excellent bond strengths at 160 degrees Fahrenheit and after JAN cycling, the low bond strength at room temperature indicates that it requires an elevated-temperature cure. This limits its use to areas where a good heat source is available.

Adhesive G appears to be fully cured at room temperature but decreases sub-

Table II. The sanding and solvent-wipe method gave bond strengths deemed sufficient for most field-repair applications, as shown below.

Adhesive Kit	*Metal cleaning method*	*Shear strength, psi, at 73°F.*
A	Acid-treated	1,500
A	Solvent-wiped followed by sanding	1,080
C	Acid-treated	2,230
C	Solvent-wiped followed by sanding	2,210

stantially in bond strength at elevated temperatures and after the JAN cycling.

Adhesives B, E, and F also appear to be fully cured but are detrimentally affected by elevated temperatures and weathering (see JAN cycle test results in Fig. 2).

Adhesives which require high-temperature cures might be used advantageously for applications such as body and minor motor repairs, where heat generated would cure the adhesive. Once cured, the adhesive would withstand the high temperatures it would encounter in such an application.

ALL the adhesives evaluated in this article should be applied at a minimum temperature of 70 degrees Fahrenheit. Cure times vary with the different adhesives, and the manufacturers' directions must be followed to effect proper cure. Most epoxy adhesives require about 7 days at 73 degrees Fahrenheit for complete cure. However, some of the adhesives attain almost full cure within 24 hours at 73 degrees. This time can be shortened even more by using heat.

In the field, many available sources of heat may be utilized to accelerate the cure cycle of adhesives. Some possible heat sources include a battery-operated heat lamp or a heater in a building or shelter. If the bonded item is portable, the manifold of a truck or tank could be used. It is essential that the adhesive be completely cured before the bonded joint is subject to stress, weathering, chemicals, or solvents.

Cured epoxy resin adhesives have been reported to exhibit good to excellent resistance to numerous chemicals and solvents including the following: salt water, engine oil, Type 3 fuel, JP4 fuel, ethyl alcohol, hydrochloric acid, sulfuric acid, sodium hydroxide, heptane, nitric acid, hydrogen peroxide, and sodium carbonate.

An adhesive such as Adhesive C, which is fast-curing and easily applied, undoubtedly could be used to great advantage in the field repair of many Ordnance items for bonds requiring quick cure (24 hours) where no heat source is available. This adhesive also could be cured within one hour at 140 degrees Fahrenheit, or 30 minutes at 200 degrees. Cure could actually be achieved in a few minutes by using temperatures around 500 degrees.

"These adhesive kits may have potential for Ordnance field-repair work, for they would make it possible for many Ordnance items that would normally be returned to a shop or Ordnance depot to be repaired in field repair stations.

"Numerous items could be repaired in almost any locality by untrained personnel, provided the directions supplied with each kit were followed carefully.

"In cases of delamination or breakage of rubber or plastic parts, adhesives are usually the only means of repair. Metal components can be adhesive-bonded to withstand service requirements for many months or even years. The use of adhesives in these cases also would reduce repair time and cost."

However, such high temperatures are not recommended for the following reasons: (1) there is much danger of overcuring, thereby decomposing and mechanically weakening the adhesive, and (2) there would be great internal stresses in the bonded joint due to the cooling effects of materials with different thermal coefficients. This adhesive recently has been recommended and is being tested for field modification of the Nike Hercules surface-to-air missile.

In order to evaluate a cleaning method that would be practical for field repair, it was decided to determine the bond strengths obtainable to aluminum when the adherend surfaces were only sanded and solvent-wiped prior to bonding. The usual acid treatment and vapor degreasing treatment are impractical for most field applications.

Specimens which had been cleaned by the sanding and solvent-wipe method were tested in comparison with acid-treated specimens. Although some loss in bond strength was observed with the sanding and solvent-wipe method, the bond strengths obtained are probably sufficient for most field-repair applications (see Table II).

The final strength of the bonded joint should be predicted on the basis of this sanding and solvent-wipe cleaning procedure rather than on the laboratory and production cleaning procedures (*e.g.*, vapor degreasing and/or acid treating) which usually are reported for such test.

The prescribed cleaning procedures must be strictly followed, and no trace of grease, paint, or other contaminant must remain on the surface to be bonded. Adhesives will not adhere to grease. If paint or any other foreign material is present on the bonding surface, the maximum degree of adhesion obtained will only be equal to the adhesion of the paint or other foreign material to the bonding surface.

With a metal surface it is very important that the sanded and solvent-wiped area be bonded immediately before oxidation occurs. Other type surfaces usually become contaminated with moisture, dust, or grease upon standing and should therefore be bonded immediately also.

In view of the findings of this investigation it would seem advantageous to the Ordnance Corps to consider incorporating an adhesive repair kit in the field-repair and maintenance kits. Such an adhesive repair kit should contain the following:

(1) A clear, precise instruction sheet; (2) One tube each of epoxy resin and hardener; (3) A flat mixing plate of wood or fiberboard; (4) Two sheets each, abrasive paper, fine (No. 400) and coarse (No. 60) grit; (5) Four wooden spatulas; (6) A container of nonflammable cleaning solvent, such as perchlorethylene; (7) A clean white cotton cloth; and (8) Several wooden applicators.

It is apparent from these studies that *all* epoxy kit adhesives are not applicable to Ordnance field use. However, those that are would be advantageous to the Ordnance Corps for emergency repair uses. In order to assure selection of the proper adhesive, these kits would be required to meet certain standards set by Ordnance.

THE requirements would include a maximum cure time and temperature plus minimum bond strengths obtained under various conditions. Further laboratory testing and field evaluation would be required prior to the preparation of an adequate procurement specification and subsequent use of adhesive repair kits in the field.

Systematic Errors

They can be detected by workable although unconventional methods

Dr. William J. Youden

DISAGREEMENTS between laboratories conducting measurements are frequent and inevitable. These disagreements grow primarily from systematic errors which are demonstrable and for which each laboratory should seek out its own sources. The following pertains to the determination of these sources of such errors.

Take two Weston cells and send them out to 10 or 12 laboratories. Label one cell X and the other Y and ask each laboratory to report back the measurement it makes on each cell. On a piece of graph paper lay off an X-axis and a Y-axis with a very enlarged scale so that it will just cover the span of values returned. Each laboratory has reported an X result and a Y result; using these as coordinates, plot a point.

If there are a dozen laboratories, there should be a dozen points, and if only random errors operate, plus and minus errors should be equally likely. The points should distribute themselves in a roughly circular manner. Find the average X and the average Y and draw a horizontal and a vertical line through that point, dividing the graph paper into four quadrants.

A mathematical statistician, Dr. Youden is with the Statistical Engineering Laboratory, National Bureau of Standards, Washington, D. C.

In theory there should be three points in each quadrant, and I will guarantee that the points will be predominantly in the upper right and in the lower left. Hardly any will be in the other two quadrants, because if a laboratory is high on one measurement as a result of a systematic error, then it will be high on the other. If it is low on one, it will be low on the other.

At a glance you have a wonderful demonstration that systematic errors are the things that are giving you trouble

It is pretty easy to get checks within a laboratory, but, of course, systematic errors are not disclosed that way. The laboratory has a particular reference standard and particular equipment and apparatus which doesn't change, so, if they repeat a measurement, they get very nice checks with high precision.

THE trouble comes when some other laboratory, with some other reference and some other set of apparatus, makes the measurement. This laboratory will check itself nicely, but it will be definitely apart from results from other laboratories. Eventually, discrepancies of this kind become troublesome.

The systematic error which I feel

Series 1	P	C	O
" 2	P	c	O
" 3	P	C	o
" 4	p	C	O

Table I. Experiments with two potentiometers, two cells, and two observers.

sure is associated with any measurement made in a particular laboratory is itself composite. The reference standard may not be exactly right. Even if the certificate for the standard cell was absolutely right the moment it left the Bureau of Standards (which we don't claim), it could change a little bit, and then when you set the value on the certificate into your potentiometer this may not represent the actual value of the cell. So a little systematic error is introduced there. The thing that makes it hard for us is that the individual systematic errors may be of the same order of magnitude as the precision error, and they are hard to detect. But it is best for each laboratory to seek out the sources of its own systematic errors.

FIGURE 1 has to do with the attempt made by the Canadians to make a determination of *g*. It is done very simply: A rod with distances marked on it is dropped and the time each distance takes to pass a given point is measured. From this, *g* is calculated. The mistake this laboratory made was to have two rods.

We only need to look at the top two drawings. There you see very plainly that the thirty-two repeat drops made with each of the two rods show a certain scatter, and their averages are definitely and unmistakably separated, although there is a considerable overlap between the individual measurements with each rod. This is the problem that confronts us in all our laboratories.

What would you do, given these results, if you had to make a report for *g* and you had no reason to believe that the distances you were assigned were any better for one rod than for the other? You'd strike an average, wouldn't you? Give them equal significance because there is nothing else to do.

Given two standard cells and one potentiometer, you might make some measurements using first one standard cell as the reference and then make measurements using the other standard cell. You have no reason to think that one cell is better than the other. They have certificates of equal date and there is nothing wrong. So you would split the difference between the two sets of results.

It might have been, however, that you had two potentiometers, and this makes the problem more complicated. You can have two cells and two potentiometers. You can first interchange the two potentiometers, keeping the same cell. You may try both cells using one of the potentiometers.

Let *P* and *p* designate the potentiometers and *C* and *c* the two cells. Measurements are made using the first three combinations:

Series 1	P	C	O
" 2	P	c	O
" 3	P	c	o
" 4	p	c	o

Table II. Experiments with two potentiometers, two cells, and two observers.

Series 1..... PC
" 2..... pC
" 3..... Pc
" 4..... pc

How can you strike an average for these three measurements? The two potentiometers are of equal merit, and you ought to split the difference for them, too, as well as for the two standard cells. You are in trouble because you have to throw away one of the measurements. There is no way, try as you may, to give equal weight to the two cells and two potentiometers except to use series 2 and 3. You average these and you have both cells represented and both potentiometers. The sensible thing here is to use all combinations, both cells and both potentiometers. After we have all four series, each cell has appeared in two of the series and both potentiometers have been used with each cell. The straight average is the best estimate, the best value. It is certainly worth while to have the fourth series.

NOTICE that if you want to compare potentiometers—say the *P* against the *p*—you can take the average of two of the measurements against the average of the other two because the two *P*'s have a *C* and a *c*, and the two *p*'s have a *C* and a *c*, so the cells balance out. This way you are getting a comparison based on averages of two determinations rather than a single determination. Each series, of course, may have a number of repeat measurements in it. The average of each series is used to represent the series.

Table I shows how quickly life can get complicated. Say that we have two observers who are going to share the burden of these observations. We have all been taught—had it ground right into our very bones—that, if you want

Table III. Use of two standard cells, X and Y, in standardizing other cells.

Test cell	*Result with Standard X*	*Result with Standard Y*	*Difference*	*Difference squared*
1	x_1	y_1	$x_1-y_1=d_1$	d_1^2
2	x_2	y_2	$x_2-y_2=d_2$	d_2^2
•	•	•	•	•
n	x_n	y_n	$x_n-y_n=d_n$	d_n^2
		Total	Σd =	Σd^2
		Ave	$\bar{d}$	

Calculate $\sqrt{\frac{\Sigma d^2-n\bar{d}^2}{n-1}} = s$

Calculate $t=\frac{\bar{d}\sqrt{n}}{s}$

If calculated *t* exceeds values listed for *t* below, there is evidence at the 95% level of confidence of a difference between Standards *X* and *Y*.

n	5	10	15	20	30	60
t	2.78	2.26	2.15	2.09	2.05	2.00

to study the effect of a variable on a system, change the variable and leave everything else unchanged. I am going to designate the standard set of equipment by capital letters. The alternate choices are denoted in the table by lower-case letters.

FIRST, change the cells, then put back the original cell and change observers. Then go back to the original observer and change potentiometers. We are in trouble when we try to take the best average. The only way to do that is to add the last three series together and subtract the first series and divide by two. This gives equal representation to capitals and to lower-case letters. The precision is no better than a single series will give.

There is another way that might occur to a clever operator. He starts out with standard conditions such as *P*, *O*, *C*. He changes *C*; having changed it, it may be a nuisance to change it back, so he leaves it there and changes observers. Then he leaves *o* and *c* and finally changes potentiometers (see Table II). This has the advantage of less switching back and forth of the required equipment. To find the effect of changing cells take Series 1 minus Series 2; to find the effect of changing observers, take Series 2 minus Series 3; and to find the effect of changing the potentiometers, take Series 3 minus Series 4.

There is only one way you can get a best value here and give equal weight to both observers, both potentiometers, and both cells, and that is to take the average of the first and fourth series. Otherwise you will get a bias. The smart thing to do is to do something that we were all taught *not* to do—change two things at once. Table IV shows such a program.

ONCE again the standard conditions are *P*, *O*, *C*. Change *O C* and *P O* and finally *P C*. The advantage is that now you can take the average of all four for your best value and get two capitals and two lower cases of each letter. Furthermore, instead of just a difference between two series to measure the effect of changing potentiometers or changing cells or changing observers, all the data are used for each effect. In the approved schedule, where you change two things at a time, to find the effect of changing cells you would take the average of the first and third and compare it with the average of the second and fourth.

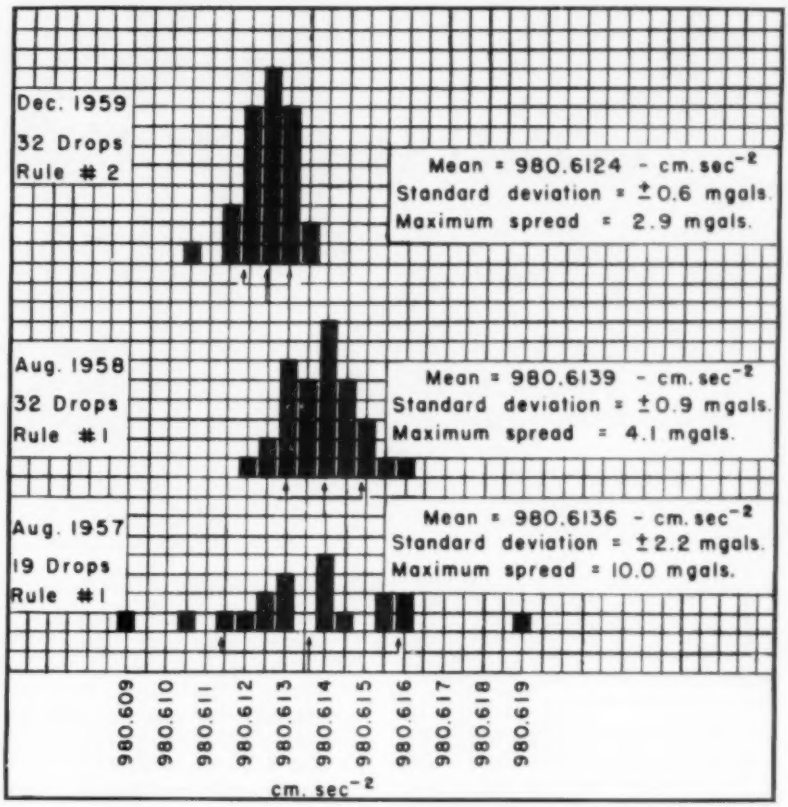


Fig. 1. Distributions of observations made from an absolute measurement of the acceleration due to gravity conducted at the Ottawa Division of Applied Physics.

You can see that the first and third series have two *C*'s and have *P* and *p* and also *O* and *o*. This is also true of the two series with *c*. Now you would be getting the effect of these changes by taking the averages of two.

Let us suppose that you have two reference standard cells which you are using to check other standard cells sent in to you routinely. In order to prevent slips, you have to check each one carefully twice.

The advantageous thing to do is to make one of the measurements against one of the reference cells and the second measurement against the other reference cell. If the cells are *X* and *Y* you will have a pair of measurements *X* and *Y* for the first cell sent in for calibration.

Table IV. Experiments with two potentiometers, two cells, and two observers.

Series 1.....	P	C	O
" 2.....	P	c	o
" 3.....	p	C	o
" 4.....	p	c	O

AFTER a number have come through your hands and nearly all the *X*'s are bigger than the *Y*'s, you have proved beyond doubt the difference between your two reference standards. No matter how nearly alike the two standards are, if the series is long enough there will turn up a predominance of either plus or minus signs in the difference column.

We have, then, a way of evaluating the two reference cells at no additional cost while doing the ordinary work. Each cell that has been measured against two of the references now gets reported and traced back to two rather than one. Table III shows a simple bit of arithmetic to tell whether we have demonstrated the difference.

Guidance for Skybolt

The new astronertial system is designed to minimize skill, manpower, and support-equipment requirements and to maximize self-sufficiency and combat readiness of units of the U. S. Strategic Air Command

C. H. Getz

THE astronertial guidance system for the Skybolt WS-138A weapon system is located in the missile and the carrier aircraft. Three of the six guidance system modules are located in the missile—the astronertial instrument module, inertial platform control module, and the ballistic computer module. Guidance modules which are carried in the aircraft are the prelaunch computer, the astrotracker control, and the portable chronometer.

Douglas Aircraft Company has the responsibility in the missile for the flight control components which receive signals from the guidance system and in the aircraft for the control and indicator panels and Bomb-Nav tie-in which feeds inputs to the guidance system. It was established earlier in the program by the Air Force, that the AN/GJQ-9 programming set would be used for implementing the aerospace ground equipment in the GAM-87A system.

Nortronics Division of Northrop Corporation has the responsibility for building test sets (previously called adapters) which will, when connected with the programming set, be capable of testing each of the guidance modules and isolating malfunctions to the plug-in subassembly level. There are five test sets for the guidance system which are used in conjunction with the AN/GJQ-9 for tests at the module level that are being built by Nortronics.

Additional aerospace ground equipment being furnished by Nortronics includes a magnetic drum test set, prelaunch computer memory fill unit, astronertial instrument check fixture, star simulator, and time standard. Self-contained component test sets to check subunits from each of the guidance modules and isolate to a failed component part have been proposed but are not funded at the present time.

Mr. Getz is general supervisor, Support Equipment, Nortronics Division of Northrop Corporation, Hawthorne, Calif. This paper was given before a meeting of the A.O.A.'s Missiles and Astronautics Division, Point Mugu, Calif.

Minimum maintenance on the GAM-87A at the flight line is performed using self-programming of the prelaunch computer to isolate malfunctions at the system level. A PLC memory fill unit (tape-programmed) is used to fill additional routines and instructions to the computer in order to isolate malfunctions to a module in the aircraft or to one of the four missiles carried by the carrier aircraft.

If the aircraft does not have missiles attached it will be possible, by connecting a missile simulator to one of the missile pylons, to check the aircraft-mounted modules. The faulty modules mounted in the carrier aircraft can be removed and replaced by spare modules and the faulty modules are taken to the base shop for repair.

In the missile system test area, a test set in conjunction with the AN/GJQ-9 programming set is used to isolate a failure in the missile to one of the modules therein. After replacement of the faulty module, the missile is then put back in ready-round storage. This missile system test set is the responsibility of the Douglas Aircraft Company. The module test area of the base shop consists of the AN/GJQ-9 programming set and the module test sets mentioned previously which are used to trouble shoot the various guidance modules.

The AN/GJQ-9 programming set is basically designed to specification MIL-P-26664A and at the present time is being built by the Bendix Equipment Division at Teterboro, N. J., on a prime contract from the Air Force. It consists of a 2-bay operator's console and a 3-bay electronic console which, when used in conjunction with a test set, will automatically program, by means of a punched paper tape, the test to be performed on a particular piece of equipment.

THE programming set contains a high-speed photoelectric tape reader and a printer which will record measured values. It contains an analog-to-digital converter which allows the equipment to make AC, DC, ratio, and resistance measurements. It also contains a hexadecimal comparator which can be used to compare decimal numbers and indicate out-of-tolerance limits which are stored in the comparator. Hexidecimal numbers also can be com-

pared, but indication or print-out is not available.

AFTER the modules have been tested and malfunctions isolated to a subunit, the subunit is replaced and the module retested and placed in storage at a SAC base. Subunits which have malfunctioned are tested on subunit testers that are grouped to repair various functional type components such as digital, analog, and electromechanical assemblies.

Normally, all modules in the astronertial guidance system can be repaired at the base shop with the exception of (1) mechanical repairs required on the astronertial instrument, and (2) the magnetic drum from the prelaunch computer.

The astronertial instrument is built to be depot-maintained because of the high skill level and special facilities required, such as a clean-room area. The magnetic drum assembly of the prelaunch computer is a depot repair item because of the skill levels required and the small tolerances that are allowed in the assembly.

Basic electronic construction in the astronertial guidance system uses small printed-circuit functional assemblies, which we call "chips," mounted on large plug-in printed-circuit cards. Isolation at the module level to these large removable assemblies allows speedy repair of the module.

Adequate test points are available on the large card subassemblies to isolate in the subunit tester to a "chip" which can be replaced.

Go-no-go chip testers are planned for the base shop to cycle spare chips and to verify chips which have been removed as inoperative. Normally, the chips are kept at a low dollar value so that they may be considered as a possible throwaway item. All the guidance modules with the exception of the portable chronometer are pressurized and require leak testing and purging equipment.

The Skybolt missile uses a U. S. Air Force B-52 bomber as its "launching pad."

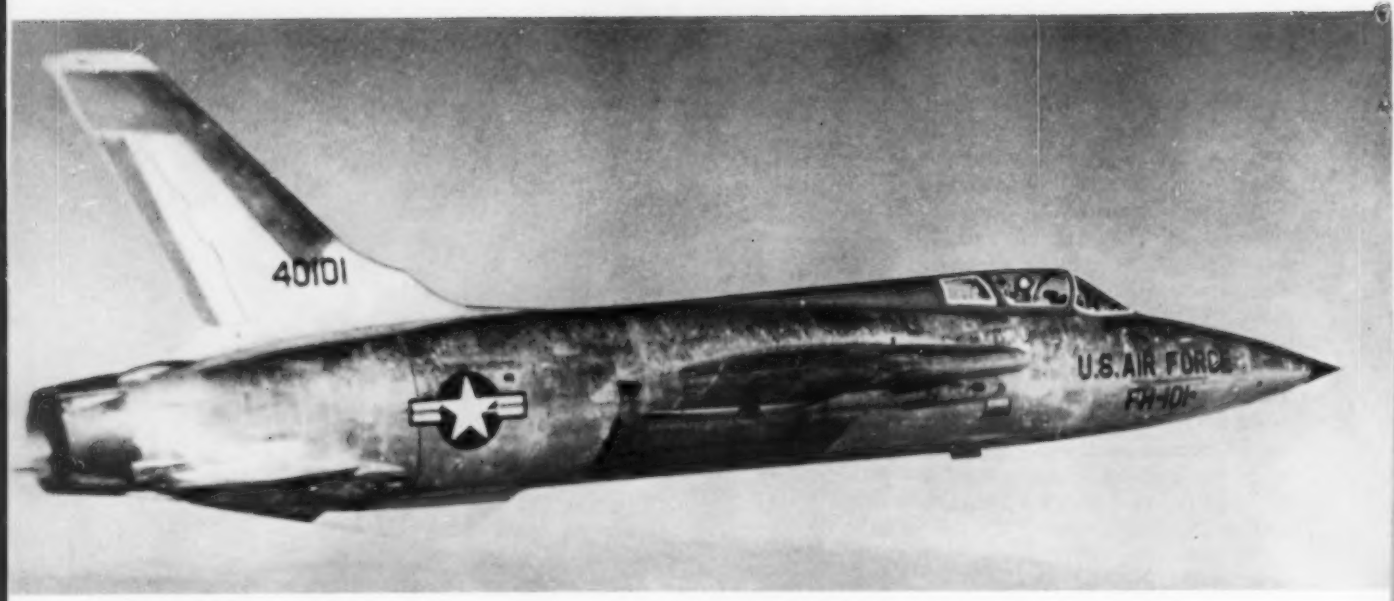
GUIDANCE modules are liquid-cooled except for the portable chronometer. The chronometer does not require pressurization because it is located in the crew compartment of the aircraft which is itself pressurized.

Optomechanical fixtures are required for testing the star tracker in the astronertial instrument. These are a star simulator, a tracker calibrator, photometer, the theodolite set for establishing the required accuracy.

A special precision electromechanical fixture is required in the depot for testing and calibrating the astronertial instrument after replacement of a faulty gyro, accelerometer, or precision resolver. This unit is used with the astronertial instrument test set and AN/GJQ-9 programming set.

The design approach of this equipment, therefore, is to minimize skill, manpower, and support-equipment requirements, and to maximize SAC unit self-sufficiency and system combat readiness.

The Skybolt is being developed to arc through space toward targets more than one thousand miles away (Air Force photos).



Flight Control Testing

Checking out the automatic control system of the supersonic F-105 airplane in actual flight is the "moment of truth" which proves the effectiveness of the preceding design and development program

R. E. Bartholomew

THE FC5 flight-control system developed by General Electric Company is now operational on Republic Aviation Corporation's F-105 Thunderchief. The Thunderchief flies at twice the speed of the F-84 Thunderjet, which was the mainstay of the Korean war. The equipment and methods for the F-105 described here will give the reader an understanding of the exact procedures which are followed in testing flight-control systems on all supersonic aircraft.

Flight testing is the "moment of truth" for aircraft systems manufacturers. Testing under actual flight conditions is the pay-off for the thorough engineering that goes into the design and development of a flight-control system. There is no substitute for a complete series of in-flight shakedowns to make certain that all the components of a system function together—reliably performing as a well-integrated whole. The equipment and testing methods described in this paper will help assure the success required of a flight test.

Mr. Bartholomew is a systems engineer, armament and control section, Light Military Electronics Department, General Electric Company, Johnson City, N. Y.

Equally important to the success of flight testing is close teamwork between flight-test engineers and test pilots. The flight-test team usually is headed by the airplane manufacturer's flight-test engineer. With the help of the flight control manufacturer's test engineers he will set up an integrated series of tests.

In order to accomplish the objectives of each flight, a very exact and formal flight plan must be set up and close liaison established between the flight control system manufacturer and the airframe manufacturer. The objectives of the individual flight must be reviewed in terms of the over-all flight-test objectives.

FLIGHT conditions for each test are judiciously chosen so that each may be measured against a reference test. A detailed step-by-step procedure is set up for the pilot to follow, and this procedure is supplemented and directed by ground radio contact. The detailed flight plan is used by both the test pilot in the air and the flight-test engineer on the ground during the flight.

The number of tests planned will be dependent upon a rigid time schedule.

Tests which will accomplish the flight objective are written down in detail. An alternate plan also is provided so that if some unpredicted trouble should occur the flight plan can be changed and valuable flight time not wasted. The flight plan is reviewed with the test pilot at the preflight meeting.

On the day of the actual test flight, radio contact is established with the pilot as soon as the engine is running. At this time, a check of the instrumentation system is performed and flight control system functions are engaged to check any possible difficulty. After take-off and climb-out, the pilot will contact the flight-test engineer and the first flight control test will be set up.

Each test is then run off with the flight-test engineer using the real-time telemetering system to observe results as fast as the tests are performed. This system receives signals from the flight-control system and, in addition to presenting real-time information, tapes them for a permanent record of the flight control's performance.

Because observation of results is possible during the flight, changes in the flight plan may be initiated by the flight-test engineer at any time during the test. The changes to the plan are noted by the pilot on his flight card and by the engineer on his radio log sheet. There is a free discussion between the test pilot and the flight-test engineer during the performance of each test in order to report spontaneous pilot evaluation of the flight control system's performance. The entire flight plan may or may not be accomplished, depending upon aircraft conditions and the apportionment of time.

DURING the flight, the flight-test engineer watches the critical parameters active in the flight-control system. The number of critical references or parameters to be recorded will be dependent upon the flight-test objectives, but the number usually will not exceed eight to twelve. For a particular test, only two or three parameters are necessary to determine whether that test is a success or a failure.

Provision is made to vary the different system parameters during flight by installing a potentiometer box in the pilot console. If cockpit space is limited, the potentiometer box may be reduced in size by using a junction box installed at another point in the aircraft—in the bomb bay area, for example. The junction box then becomes the point at which the cockpit potentiometers are wired to the different functions of the flight-control system.

In addition to potentiometers, the box contains a number of switches which can be used to activate or deactivate various autopilot functions during flight. The number of switches used will depend upon the system complexity and the flight-test objectives.

A limited amount of data analysis is done during a flight. Various strategic signal points in the autopilot system are checked by the flight-test engineer to determine how the system is operating. Because of the number of instrumentation points and wires involved, an instrumentation junction box is usually necessary. The number of pick-off points from which to obtain data is considerably greater than those used for any one flight. The instrumentation junction box is the point at which the selection of signals for each flight takes place. A special electrical cable connects the autopilot amplifier to the instrumentation junction box so that these points may be selected and measured as the situation requires.

At the same time that the flight-control system itself is tested, aircraft controls also should be observed. Of vital importance are the stabilizer, rudder, and spoilers. In order to analyze the performance of a flight-control system, the aircraft control linkages and power-boost system also must be considered. Surface pick-offs tied in with the instrumentation system provide the position information necessary for the flight-test engineer to measure important aircraft control system characteristics.

The flight records may be reviewed during a postflight conference between the test pilot and the flight-test engineers, particularly when there are areas of confusion which could not be resolved sufficiently during the flight. The flight record is compared against the expected results for each test, and the results of each test are later recorded to form an important part of the flight-test report.

Flight testing has come a long way since the heyday of the F-84. The complexity of electronic and hydraulic systems used in the F-105 provides the flight-test engineer and maintenance personnel with challenging problems. During the flight, these test problems are solved and passed back into production.

IN this age of Mach 2 aircraft, the flight-test engineer is faced with increased operating costs, and the efficient planning of each flight test means the saving of thousands of dollars. The engineer's planning must be thorough and yet flexible, so that each bit of information gathered is fully utilized in future planning.

A lot of things can happen once the test pilot steps into the cockpit of his F-105, and the flight-test engineer must be prepared for almost every possibility —he has no time for hindsight. Once the brakes are released for taxiing, the pilot's energies will be devoted to flying one of the fastest planes in the sky.

The ground receiving portion of real-time telemetering equipment permits analysis of aircraft control system performance data during actual flight test.

ABC's of BLC in ASW

There are a number of known methods for reducing the drag on an underwater vehicle by control of the boundary layer and further research may result in the complete elimination of this factor

Dr. Charles E. Carver, Jr.

An associate professor of civil engineering, University of Massachusetts, Amherst, Mass., Dr. Carver also is a consultant to the Undersea Weapons Engineering Unit, Ordnance Department, General Electric Company, Pittsfield, Mass.

TO those readers like myself who have been unable to keep up with the alphabetical jargon which punctuates the technology of today, the free translation of the title of this article is as follows—it deals with some of the fundamental ideas behind the theory of boundary-layer control (BLC) and how they may be adapted in practice to improve the performance of antisubmarine warfare (ASW) weapons systems, in particular the torpedo.

Before discussing boundary-layer control and its application to torpedoes, it may be helpful to review some facts regarding the boundary layer itself. The concept of the boundary layer was introduced by Prof. Ludwig Prandtl at the turn of the twentieth century. The theories of classical hydrodynamics had reached a high degree of perfection prior to this time, but they dealt predominantly with a so-called "ideal fluid"; that is, one of zero viscosity.

The resulting potential flow solutions as such could predict neither the skin friction drag nor the form drag resulting from flow separations due to viscous effects on a submerged moving body.

Prandtl reasoned that such viscous effects were confined to a relatively thin zone next to the boundary which he termed the boundary layer. Outside this layer, however, the fluid was assumed to behave as an ideal one. The fluid velocity at the boundary of the body must be zero, increasing to that of the free stream across the thickness of the boundary layer. Very high viscous shear stresses, which we have come to term "skin friction," result at the boundary of the body.

The phenomenon of separation is nicely explained by the boundary-layer concept also, for we now visualize slowly moving fluid particles within the boundary layer being robbed of their energy, coming to rest, and finally peeling off as eddies to form a wake.

Professor Prandtl's concept of the boundary layer, which has withstood experimental refutation to this day, is depicted exaggerated in vertical dimension in Figure 1 as it develops and grows in thickness along the surface of a torpedo, for example. In this case the torpedo is assumed to be at rest with a uniform free stream of velocity U streaming past it. At first a laminar boundary layer develops, growing in thickness with distance from the nose of the torpedo. This layer eventually becomes unstable and is followed by a transition zone after which the layer becomes fully turbulent.

Of significance is the fact that theory and experiment tell us that the viscous drag in a turbulent boundary layer is about five times that of a laminar boundary layer. The point of transition depends upon many factors, notably upon the surface roughness of the torpedo, the degree of turbulence indigenous to the oncoming free stream flow, and the intensity of adverse pressure gradients within the boundary layer.

In the turbulent zone and adjacent to the boundary lies an extremely thin layer which still exhibits the characteristics of laminar flow and, hence, has been termed the laminar sublayer. In general, the roughness elements of most torpedo surfaces are not sufficiently high to protrude through the laminar sublayer, and we say that the flow is "hydraulically smooth." Finally in Figure 1 we see the flow separating on the afterbody and creating a turbulent wake.

WITH these characteristics of the boundary layer in mind, how then, are we able to control it so as to reduce the total drag of the vehicle? There are at least five known methods for controlling the boundary layer: (1) Motion of the boundary surface, (2) Accelerating the boundary layer, (3) Removing some of the boundary layer by suction through a porous surface, (4) Preventing the transition from laminar to turbulent flow by provision of suitable shapes or so-called laminar profiles, and (5) The method of distributed damping.

Methods 1 through 4 were first experimentally demonstrated by Prandtl; indeed, they were offered as proof of the validity of his boundary-layer con-

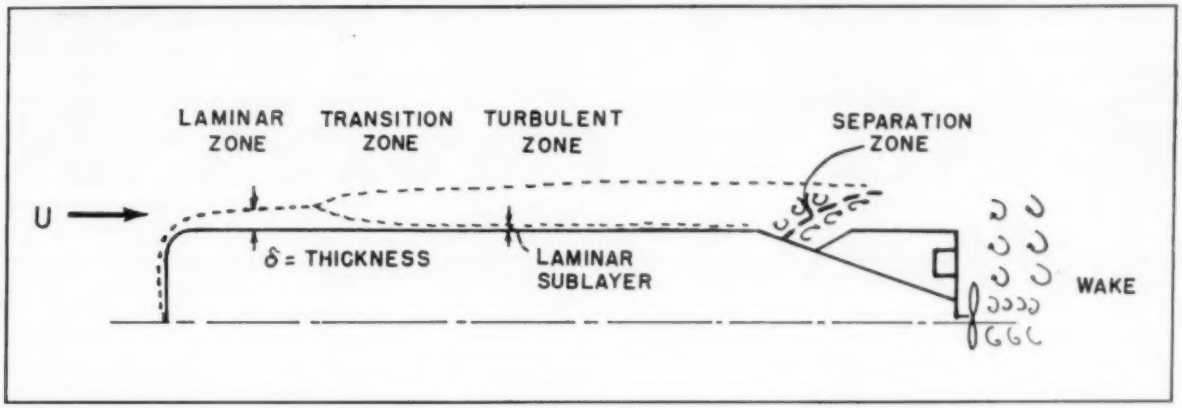


Fig. 1. Boundary layer growth on a torpedo body showing the flow separating on the afterbody and creating a turbulent wake.

cept for they follow as logical consequences of the fundamental ideas he put forth. The last method, distributed damping, is a relatively recent innovation about which we shall have more to say later. Let us now examine the first four methods with reference to their applicability to the torpedo.

IT is not difficult to see intuitively why Method 1 works, for if the boundary itself were to move at the same velocity as the oncoming flow there would be no relative motion between boundary and free stream flow—and hence no viscous shear stress could exist. The viscous drag would be zero, and there should be no tendency for the flow to separate.

In an early experiment, Prandtl showed that a stream of fluid, passing over a cylinder rotating in the direction of the flow, hugged the cylinder without separation while a stream flowing over a motionless cylinder separated at the rear of the cylinder.

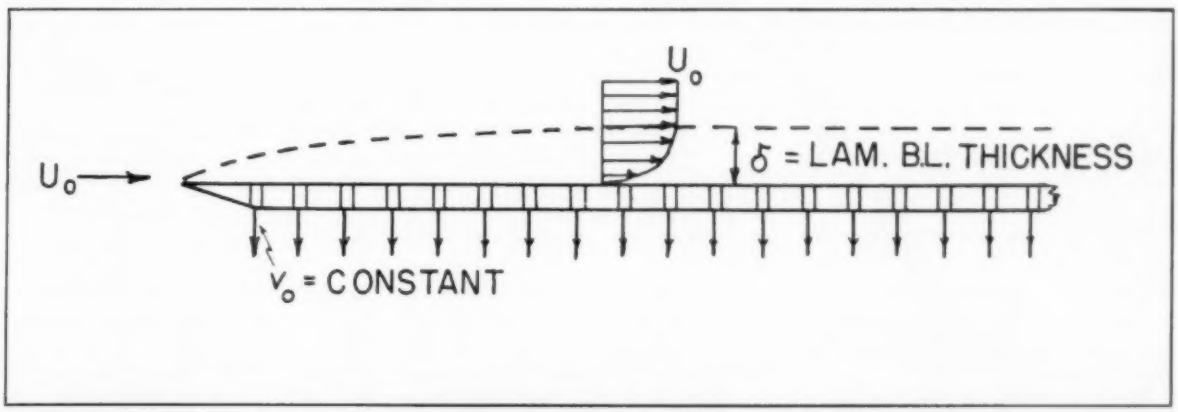
The reader will no doubt appreciate the mechanical difficulties involved in this type of control, for we would have to make the surface in the form of an endless belt always moving in the direction of the oncoming flow. For this reason we shall eliminate this form of control for torpedo use from further consideration.

The second method, accelerating the boundary layer, is sometimes referred to as "blowing." The objective here is to inject high-energy fluid into the slower-moving particles in the boundary layer, allowing them to proceed farther along the boundary before separating from it. Ideally, the reduced wake results in a drag reduction. Practically, however, the process tends to be highly unstable, especially when attempts are made to supply additional energy to a laminar boundary layer, for it is likely to become turbulent, resulting in increased drag. This approach, therefore, does not appear to be very feasible for torpedo application.

Jumping now to Method 4, the use of laminar shapes to prevent transition from laminar to turbulent boundary layers, we remark simply that the method is more amenable to the design of airfoils and that too many other design considerations stand in the way of presently adopting a suitable laminar profile for torpedo use which would result in any significant drag reduction.

METHODS 3 and 5, area suction and distributed damping, appear to hold the greatest promise for effecting substantial percentages of drag reduction. The objective of area suction is to maintain a laminar boundary layer, never allowing it to become turbulent and thereby reaping the benefit of the lower viscous shear stresses associated with laminar boundary layers and reducing the size of the turbulent wake which in turn lowers the form drag. It has been estimated that total drag variations up to 50 per cent may be achieved by this method of control.

Fig. 2. Schematic drawing shows the method of boundary-layer control on a flat plate by area suction.



Boundary-layer control by area suction is certainly not new. It has been applied successfully in the field of aeronautics for many years, being used specifically for airfoils. The method of boundary-layer control by area suction is illustrated schematically in Figure 2 which shows a flow of oncoming velocity U streaming past a porous flat plate at zero incidence with fluid being withdrawn uniformly through the plate at a constant velocity V_o. The laminar boundary layer growth is shown together with a typical velocity distribution, which is very nearly parabolic within the boundary layer.

The amount of fluid to be removed through the porous skin in order to maintain or stabilize a laminar boundary layer has been determined from theoretical considerations which are outside the scope of the present article. It is, however, a relatively small quantity; indeed, if too much is removed the boundary layer may become so thin as to expose the surface roughness elements.

When this happens the boundary layer will become "tripped"; that is, it will go turbulent and result in increased drag. The power required to effect the withdrawal of fluid through the porous skin must, of course, be charged against the total drag reduction, but it is nevertheless quite small.

IN Method 5, boundary-layer control by distributed damping, the governing mechanism is quite different. This approach was pioneered by Dr. Max Kramer as a result of careful studies of the propulsion characteristics of the porpoise and a detailed examination of the skin of this mammal. Dr. Kramer conceived an artificial skin consisting of two flexible rubber sheets separated by many tiny rubber columns or fingers, the space between the columns being filled with a viscous silicone oil.

It is not clear at present as to the precise mechanism by means of which drag is reduced by distributed damping. Some hold that the pressure fluctuations associated with turbulent velocity fluctuations in the boundary layer are damped out by the elastic skin, and that a laminar boundary layer is thus produced, or at least the transition point from a laminar to a turbulent boundary layer is delayed.

Another school of thought seems to reason that a turbulent boundary layer does in fact exist on the boundary, but that the velocity distribution is altered by the skin in such a way as to produce a smaller velocity gradient at the surface of the skin, producing thereby a diminished shear stress. Whatever the mechanism, total drag reductions of 30 per cent have been reported from experiments with an elastic skin.

"Boundary-layer control holds considerable promise for achieving significant drag reduction on torpedoes. We should remark also that the maintenance of a laminar boundary layer is likely to contribute to a reduction in flow noise as well. We have not exhausted all the possibilities for BLC; indeed, studies of the propulsion characteristics of fish may lead to quite radical designs from the conventional ones we now have. Finally, another technique under serious study would surround a torpedo with a thin gas sheet so that the missile swims in its own gaseous cavity."

How might BLC by area suction be applied to a torpedo and what are some of the problems we may expect in such an application? Engineers of General Electric Company's Ordnance Department, Undersea Weapons Engineering Unit, Pittsfield, Mass., are currently engaged in a comprehensive study of this problem, involving, first, the investigation of a number of possible porous materials and, secondly, the adaptation of the most suitable material to the design of a prototype vehicle for the eventual demonstration of drag reduction.

In regard to the first objective, the ideal porous material must possess certain characteristics to function effectively. It must be quite smooth in order not to trip the boundary layer into a turbulent one. It must be noncorrosive, be resistant to abrasion, possess adequate structural strength in tension and compression, and resist impact loadings.

It is particularly important that the porosity of the material be uniform and that the pressure drop across the skin be of the order of one to two pounds per square inch. This keeps the power requirement necessary to effect suction at a low value and prevents the possibility of "blowing" which involves a reversal of flow outward into the boundary layer and leads to instability.

INASMUCH as the pore size of the material amounts to but a few mils, the reader will appreciate the fact that the most serious problem to be encountered with operations in the oceanic environment will be the clogging of the skin by the plankton or suspended inorganic sediments. It is desirable, therefore, that a backflushing feature be incorporated in such a vehicle which would come into play when the increasing differential pressure across the skin due to clogging reached a specified value.

Another problem will be to determine the effect of angle of incidence of the vehicle on maintaining the stability of the laminar boundary layer when BLC by area suction is in operation.

Many of these problems can be studied in the water tunnel while others, notably the plankton clogging problem will require going to sea for tests. Engineers plan to construct a portable water tunnel which will be taken aboard a ship for the purpose of investigating clogging effects on various porous materials. Sea water with different plankton densities will be pumped at prototype torpedo speed past a test cylinder in the tunnel while area suction is applied to the cylinder.

In summary, boundary-layer control holds considerable promise for achieving significant drag reduction on torpedoes. We should remark also that the maintenance of a laminar boundary layer is likely to contribute to a reduction in flow noise as well. We have not exhausted all the possibilities for BLC; indeed, studies of the propulsion characteristics of fish may lead to quite radical designs from the conventional ones we now have.

Finally, another technique under serious study would surround a torpedo with a thin gas sheet so that the missile literally swims in its own gaseous cavity. Since the shear stress at the boundary is a function of the density of the medium surrounding the boundary, the use of a gas of low density compared with sea water could result in drag reductions of the order of one hundred per cent.

ARMA guides Air Force ATLAS in first full-range inertial flight

Cape Canaveral July 7, 1961. The Air Force announced the successful flight of an Atlas ICBM guided by the Arma inertial system 9,000 miles into the Indian Ocean.

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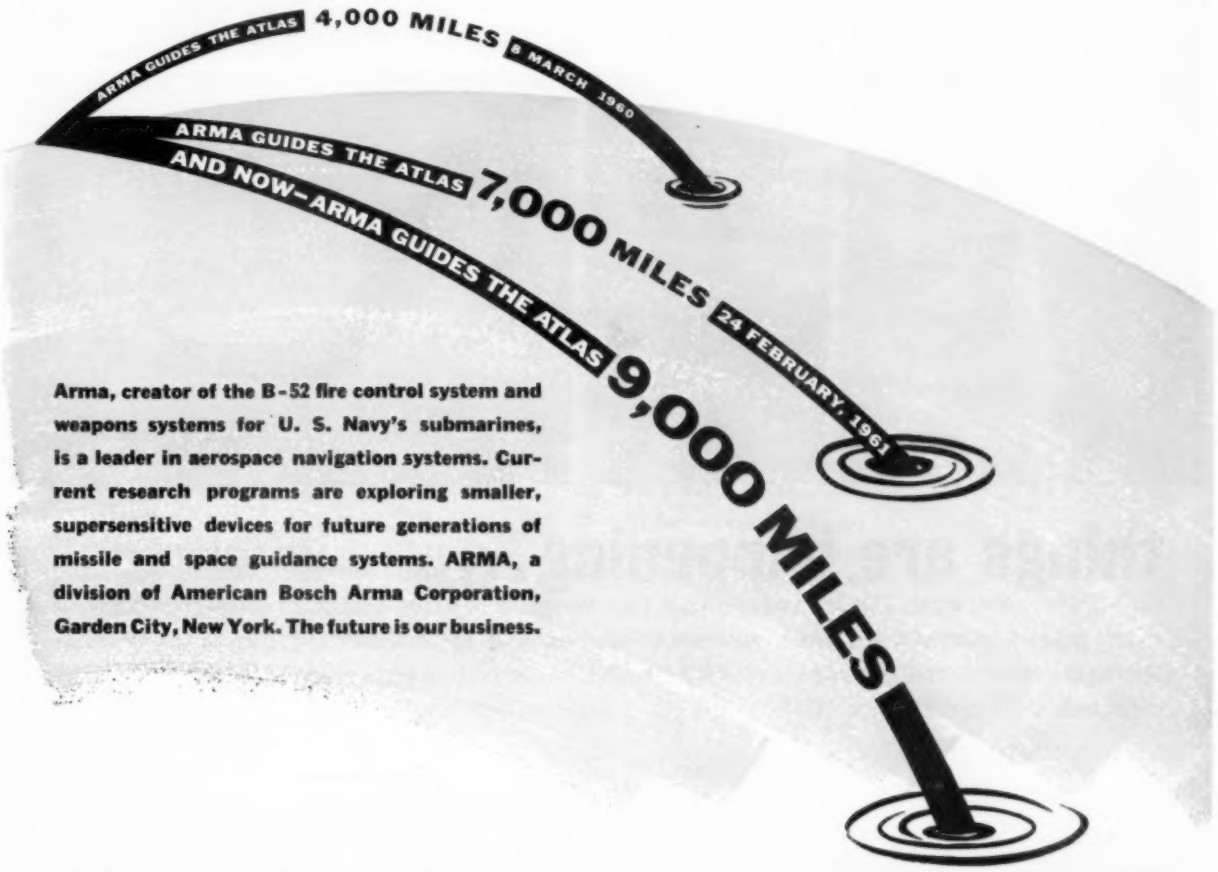

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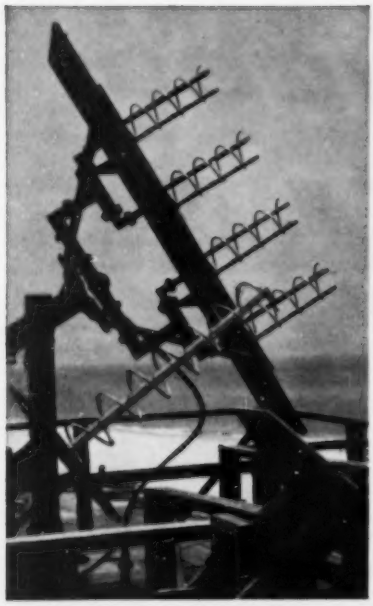

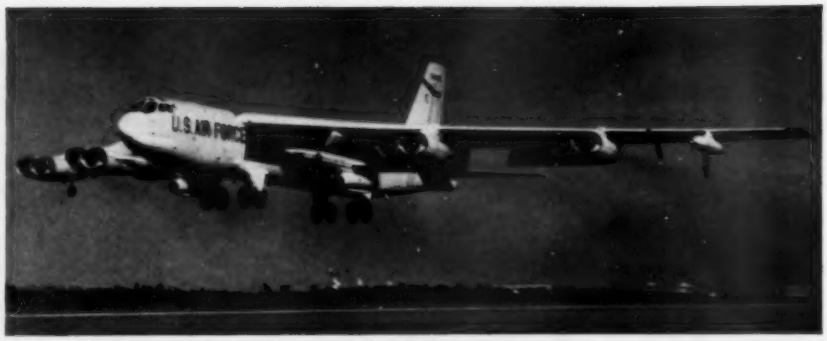

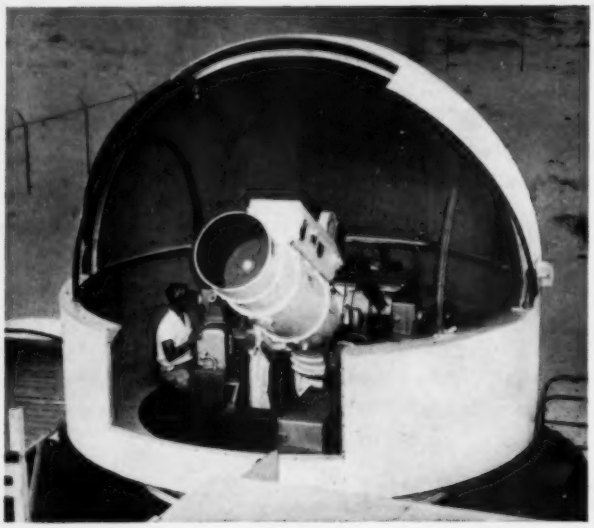

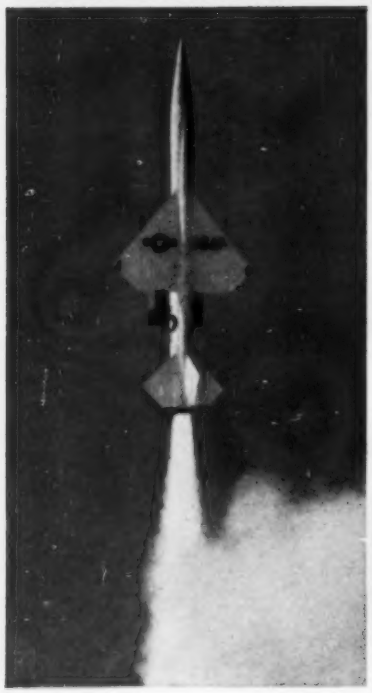

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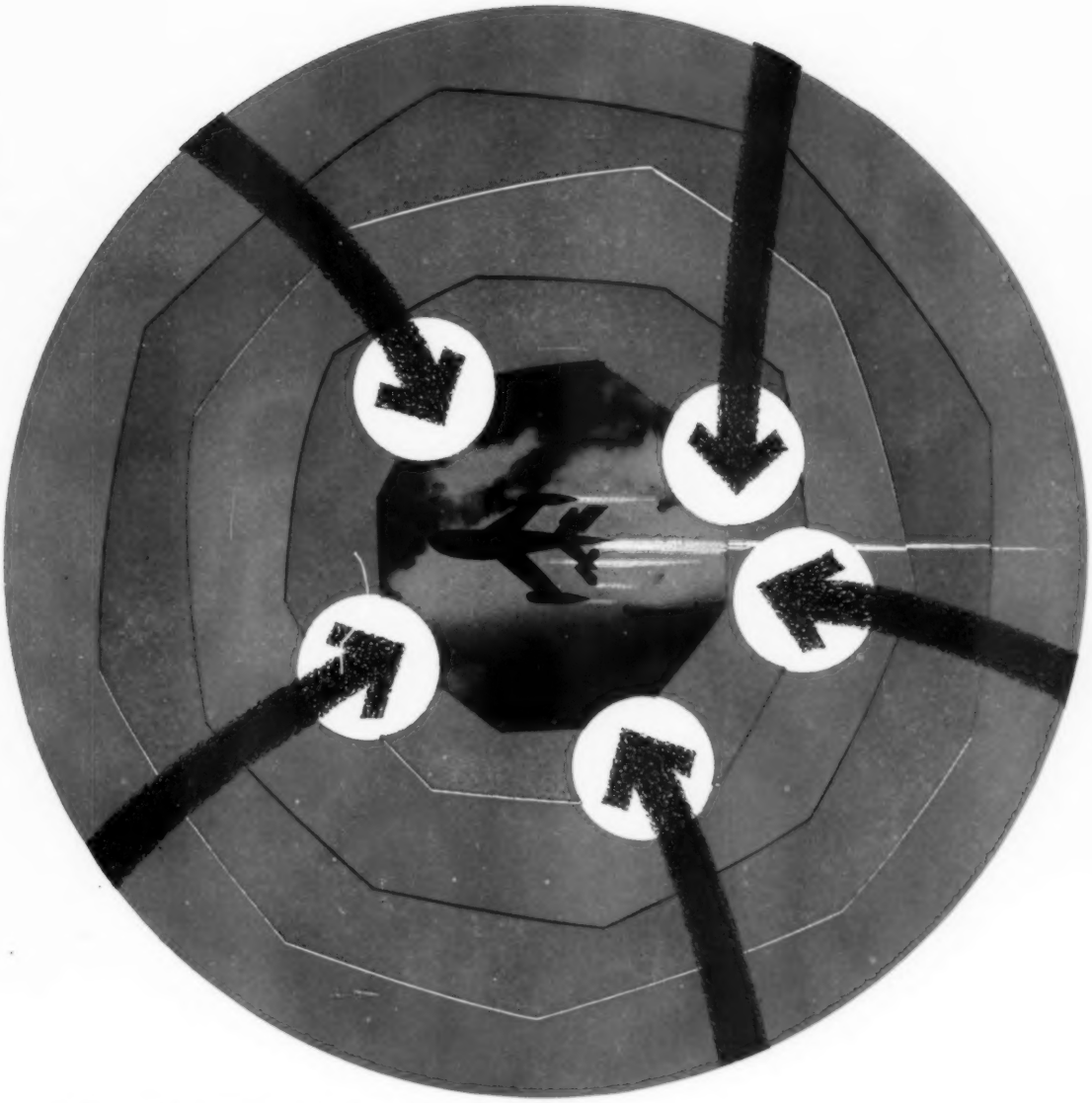

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Today's increasing air traffic demands faster and safer all-weather operation at every airport.

Bell brings this goal one important step closer with its All-Weather Automatic Landing System (ALS) which can fly two airplanes to touchdown every minute, even when visibility is absolutely zero.

The Bell ALS takes over when the pilot brings his plane through the electronic "window in the sky" and guides it to a safe and sure landing.

The system has been flight-proved in more than 4,000 landings with all types of aircraft—small private planes as well as airliners from the DC-3 and DC-7 to the huge Boeing 707 jet. It now is being evaluated at FAA's National Aviation Experimental Center, Atlantic City, N. J.

Unlike other automatic landing systems, the Bell ALS is ground-based so a ground observer monitors every approach and landing. It can operate either fully automatically or under pilot control.

Military versions of the ALS have been ordered by the Air Force. The Navy has selected it for installation aboard the nuclear-powered aircraft carrier USS Enterprise as well as for its other large carriers.

The Bell ALS is but one among many contributions which Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

BELL AEROSYSTEMS COMPANY
BUFFALO 5, N. Y.
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